

# **Army Maintenance System Transformation**

**A Monograph  
by  
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## Abstract

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The first official use of the term “transformation” is often attributed to the document *Joint Vision 2010* published in 1996. Logistics, an integral component to this transformation, is adjusting as well. As a part of logistics transformation, maintenance has been thoroughly reworked. Maintenance transformation must address the issues presented by a transforming Army while it is at war. General Systems Theory offers many valuable insights into how a transformed maintenance system should develop. Used in conjunction with pertinent historical data and developed with Army transformation goals in mind, general systems thinking can provide the framework for guiding maintenance transformation. System aspects such as stability, interaction and feedback provide the universal qualities that any valid system must possess. Applying these aspects to the pillars of Army maintenance system transformation, multi-capable maintainer, conceptual foundations, maintenance organization and CL IX (repair parts), will provide principles to guide the development of transformation as a whole, recognizing the impact of several systems that must work together. The paper will show that maintenance transformation, as it is understood currently, is insufficiently resourced to meet the requirement of adequately maintaining the Army’s operational readiness. A section is devoted to the issues that face the maintenance system today that can be resolved without solutions that are transformational in nature or spurred by a revolution in military logistics and mainly involve enforcing standards and instilling discipline into the maintenance process. Finally, the impact of the debate between effectiveness and efficiency proves useful in prioritizing efforts and designing the maintenance system to ensure it is resourced to sustain the Army in its continuing mission of fighting and winning our Nation’s wars.

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# I. INTRODUCTION

## Year 2020

The year is 2020. The political climate between the major nations of the world has changed dramatically in the last 15 years. Due to the global nature of business and the reality that it imposes, the United States has significantly stepped up its efforts to establish economic ties with countries around the world. The United States government realized that if it wanted to maintain its global influence, it would have to adjust to the world economic situation such as the exodus of information technology jobs to India that began at the turn of the century and the seemingly endless supply of cheap labor in China and now Africa. Ties with Russia have strengthened, not only because of a now shared ideology and the modest successes their fledgling democracy has achieved, but also because of its growing oil production capability. Despite the press that alternative energy sources have received, the United States, along with the rest of the world, is still very dependent on fossil fuels, even more than before because of the increased requirements of a developing world. This dependency of fossil fuels has also led the United States to Africa, where massive oil reserves have been discovered resulting in opportunistic companies from around the world to converge, hoping to lay claim to a share of the business.

This influx of commercial entities, not only from the west, but also from Russia and Asia, has brought an unfamiliar amount of wealth to a part of the world that has been historically poverty-stricken and rife with conflict. The presence of foreign business enterprises in a region with little or no adherence to the rule of law has drawn the attention of terrorist organizations from around the world. These groups see this as an opportunity to strike at and drive out, what they perceive as negative western influences. This would allow them to control this newly developed wealth and use it to further their own cause, which is to spread their anti-western ideology and impose a theocracy throughout the entire region. The activities of the terrorist groups, which were once limited to demonstrations and minor violence, have escalated to outright

attacks on essentially defenseless foreign companies, both from the United States and its allies. There are signs that certain countries' governments are susceptible to being overthrown by terrorist groups. These countries, all failing states that are essentially democracies in name only, are asking for assistance to stave off these coup attempts and help stabilize their nation. The country that is most at risk is Chad, a failing state unable to control its own territory, with nearly unlimited natural resource development potential and is on the verge of a complete governmental collapse.

Economic prosperity is only one reason the United States has increased efforts to establish positive relationships with other major countries. The United States realizes that conflict between major powers is greatly reduced when a beneficial economic relationship exists between nations. Another significant benefit of these closer relationships is that they assist the United States and its allies in a conflict that has been raging for decades, the Global Struggle Against Violent Extremism or GSAVE (formerly known as the Global War on Terror).<sup>1</sup> With only limited strategic success at the onset of the conflict, the United States realizes that a network of cooperating countries is needed to counter this pervasive and elusive threat. With the possibility of major, high-intensity conflict reduced, the United States has been able to devote more resources to the GSAVE. This ubiquitous threat has created the need for smaller scale, concurrent operations in multiple and distant locations, or split-based operations, which requires a different kind of logistics support than the cold war years.

As a result of this need, the Army, as part of its ongoing transformation effort, has concentrated on making its logistics systems capable of supporting split-based operations of this nature, while still able to support large scale, high-intensity conflicts. The nature of GSAVE has

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<sup>1</sup> The first use of the acronym GSAVE is often credited to Donald Rumsfeld in July, 2005 in a series of press conferences in attempt to lessen the military-centric overtones of the former title of the conflict which was the Global War on Terror (GWOT). Tom Regan, "The 'rebranding' of the war on terror" The Christian Science Monitor, 28 July 2005 [journal on-line]; available from <http://csmonitor.com/2005/0728/dailyUpdate.html>; Internet; accessed 7 March 2006.



made the Army and Marine Corps the dominant services which has resulted in additional resources devoted to these branches in an effort to posture them to take on this massive undertaking.<sup>2</sup> Much of this effort has come in the name of transformation which has been ongoing for many years. Many leaders, both military and civilian question whether the national treasure allocated to the transformation effort has been effectively utilized and say that the transformed force is ill-prepared to deal with the ongoing terrorist threat.

Logistics has been thoroughly retooled as a result of transformation. It has been distribution based for years. The systems and processes in place give logisticians all over the world real-time information that allow them to influence the supply chain to best meet the demands of an Army that is operating world-wide. The individual requisition level, the supported unit and operational oversight agents are all linked to this distribution pipeline. The Defense Transportation System (DTS) and the Joint Planning and Execution System (JOPES) are merged. The logistical and operational communities now operate with real time, accurate knowledge of logistics.<sup>3</sup> Requirements and shortfalls are detected, quantified, requested, verified and shipped in a matter of minutes instead of days. Sense and Respond Logistics allows logisticians to view the distribution pipeline for specific commodities or units and determine where commodities will come from and forecast effects on the distribution pipeline.<sup>4</sup> This will enable logistics managers to mitigate possible problems in the movement of items as well as focus their ability to interact with other nodes in the pipeline from the manufacturer to the supported unit. Logisticians at all levels will have “watch boards” on their computers with continuously updated data that highlights shortages of units they support.<sup>5</sup> With this information, they will be able to quickly adjust

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<sup>2</sup> Williamson Murray, Lecture to School of Advanced Military Studies, Fort Leavenworth, KS, 2 December 2005.

<sup>3</sup> United States Army Logistics Transformation Agency, *Logistics in the Year 2015* [database online] (Fort Belvoir, VA, 2005, accessed 26 October 2005); available from [https://lss.lta.army.mil/ako\\_pwd/fl/logvig2015.doc](https://lss.lta.army.mil/ako_pwd/fl/logvig2015.doc), p. 3 of 11; Internet

<sup>4</sup> Ibid, p. 11 of 11.

<sup>5</sup> Ibid, p. 3 of 11.

supplies moving to supported units and alleviate shortfalls before their negative affects are even felt.<sup>6</sup>

Supplies coming into a theater of operations are able to be tracked down to the individual item, despite being shipped in large containers which may have hundreds of parts ordered by dozens of units because of discrete and detailed data contained in each container. The improved accuracy of this data is due to the DOD wide implementation and procedural standardization of radio frequency identification (RFID) technology use. Each item has a material release order that is associated with a radio-frequency (RF) tag. When all item information is accurately burned onto a data card, the data card is then associated with the RF tag and shipped, possibly in an air line of communication (ALOC) configuration involving a 493L pallet<sup>7</sup>. This pallet allows the consolidation of all items going to a particular theater. Once it arrives at the Theater Distribution Center (TDC), the items may have to be delivered to different theater distribution hubs. The 493L pallet allows for this with its ability to have parts of it detached with just the items going to a particular theater distribution hub. When the pallet is configured at the TDC for onward movement to its separate hubs, the original data card and RF tag are updated with this information and new cards and RF tags are issued to the individual hub shipments. This allows for beginning-to-end supply chain visibility and management.<sup>8</sup> Because the pallet segments are interchangeable and standardized, they can be collected and reconfigured at each of the hubs and retrograded for future use.

Maintenance has also been transformed to keep pace with the improved distribution system. When a maintenance issue presents itself, the assets of all the services are reviewed to find the best possible solution. Repair sites are queried, all stocks to include bench and shop

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<sup>6</sup> Ibid., p. 4 of 11.

<sup>7</sup> 493L pallets are a fictional pallet used to help frame how supplies may be transported and shaped in the future.

<sup>8</sup> Today, in-transit visibility (ITV) is often lost when ALOCs/463L pallets are broken down at distribution hubs because item data is not transferred to the new data card on the newly configured platform.

stocks are viewable, direct interface with manufacturers is possible and funding is no longer an issue as the COCOMs now employ Directive Authority for Logistics and can prescribe the allocation of maintenance assets and resources as it sees fit, regardless of service affiliation.<sup>9</sup>

Combined with a standardization of parts and diagnostic processes and test equipment, the maintenance overhead in the joint environment is significantly decreased. With the readiness status of all units available from a collaborative and continuously updated database, maintenance assets can be diverted, surged and allocated as the mission and situation dictates. CL IX (repair parts) can be viewed throughout the entire distribution pipeline and re-allocated to higher priority requirements. Priority designator (PD) abuse is no longer an issue as all services strictly adhere to Department of Defense (DOD) wide regulations regarding PD use. Surge capability is enhanced through a direct interface with vendors requesting an increased production of required parts. Vendors will have visibility of readiness status and will react to situations quickly in accordance with pre-determined guidelines established by the DOD. All platforms in the DOD inventory will have on-board sensors that automatically transmit diagnostic data to logistics databases and forecast component or assembly failure. This will not only increase readiness of the Services' fleets, but will also save money in repair costs as potential failures are detected before actual component failure occurs. These on-board sensors will also collect maintenance data, such as petroleum, oil and lubrication (POL) usage, which will let maintenance technicians determine usage trends and adjust prescribed maintenance procedures accordingly.

Uniformed maintenance personnel are greatly augmented by civilian contractors who are technical experts in the maintenance of the vehicle fleets and travel wherever the unit's mission dictates. Costly and cumbersome test equipment requirements are greatly reduced with the change in the maintenance concept of "fix forward" to "replace forward." Instead of component

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<sup>9</sup> Ibid., p. 4 of 11 (a new funding scheme in the logistics of the future). Bench and shop stocks today are non-viewable assets in the supply system. Bench stock is low-dollar, high usage items and shop stock is normally high-dollar, recoverable items. Both are stocked and used by direct support (DS) maintenance sections to facilitate quick turn around time of repairs.

repair, which requires extensive diagnosis and transportation-intensive test equipment, the component is simply replaced. This “replace forward” concept is facilitated by the streamlined and responsive distribution system that stems from the velocity management approach to supply chain management. Along with velocity management, just in time (JIT) logistics serves as the model for supplying the worldwide, expeditionary Army. The Army, in coordination with the Joint Logistics Command (LOGCOM), analyzed the civilian business practices of successful global corporations and adopted their system of supply chain management. This not only facilitates better supply chain management in and of itself, but also aligns the services with current and proven business practices that allow for a more seamless integration of military readiness procedures and multi-national corporation business practices. These concepts allow for a much smaller authorized stockage list (ASL) to accompany support and contractor units into theater, increasing their mobility and decreasing inventory carrying costs and transportation requirements.

## **Year 2006**

This vignette portrays just a few of the views and aspirations envisioned by the logistics community today. It could go on almost endlessly with all of the marvelous developments being planned in the name of logistics transformation. In order to transform something, it must be understood where the system is currently, what needs to be changed or improved and finally what the desired end-state of the system should be. The term end-state does not mean that transformation will end at a certain point when a system has specific characteristics. To the contrary, transformation is a process that will go on continuously, always adapting to the emerging needs brought about by world events and conditions. The Army has always engaged in transformation even when the process was not identified by the moniker of transformation. For example, the move from functional support battalions to multi-functional support battalions and the use of air assault tactics by the 1<sup>st</sup> Cavalry Division in Viet Nam was transformational.

Another way of thinking of past transformational efforts is to think of them as adaptations. During a recent discussion at Fort Leavenworth, Kansas, a senior Army official said that the term “transformation” is a good way to capture the set of changes or adaptations that are being made. There is a definite benefit to labeling the Army’s current efforts as “transformation.” First, it gets everybody in the organization to understand that their environment is changing. Second, it provides, or should provide, a framework for the nature of the change. An important consideration for senior Army leaders today is to get everybody on board with transformation. Labeling this change lays the groundwork and begins to establish the lexicon that will be critical to the discussion of transformation. Third, it assists in establishing the mindset required by all members of the organization to effect transformational change. Without buy in from the members of an organization, or at a minimum, a basic understanding of the transformational process and its aims, any effort to change will be doomed to failure.

Once this transformation language is established, discussion on the nature of the changes must be discussed in great detail and at all levels. It should be discussed in papers, articles, in the education system and in officer professional development (OPD) sessions. Unfortunately, many of the emerging concepts on current Army transformation efforts are unclear because doctrine is constantly changing, is in draft form, or is not even published. What this monograph proposes to accomplish is to analyze maintenance transformation and determine its success in meeting the needs of the transformed force. To do this, the roots of transformation will be reviewed to determine why it is necessary to transform and what the goals of transformation are and what they should be if they do not meet the determined requirements. It will be made clear that maintenance transformation will not produce a maintenance system that is sufficiently resourced to complete its mission of sustaining operational readiness. General Systems Theory will be explained and then used to gauge the level of synchronization and effectiveness of the maintenance system and the force it must support. General systems theory is useful in this pursuit because it looks at components of a system, or sub-systems, and determines how well they

work together as a whole to a desired end or resulting process. Maintenance itself is a sub-system of readiness, which in turn is a sub-system of combat power. Understanding the ramifications of changes in a sub-system and its potentially disproportional effects to higher systems is vital to this analysis. The General Systems Theory discussion will include system stability, interaction, feedback, a brief overview of complex systems and last section will deal with system survival.

After the discussion on General Systems Theory, this paper will look at the components of the Army maintenance system as transformation efforts have designed them and determine the feasibility of the transformed maintenance system by gauging against general systems concepts and practical application. To be successful, Army maintenance system transformation must be properly resourced to meet the needs of the Army in its ongoing campaigns and those of the future. This paper will focus mainly on ground maintenance transformation although many of the concepts transfer to the aviation maintenance arena. For purposes of clarity, further references to maintenance will be understood as ground maintenance in context. The areas of the Army maintenance system relevant to the analysis and discussed in this paper are the multi-capable maintainer, conceptual foundation, organization and structure, and impact of recent CL IX (repair parts) changes.

The discussion of the multi-capable maintainer will include an analysis of military occupational specialty (MOS) consolidation and elimination and how they impact how the Army maintains itself. The section on conceptual foundation transformation changes will focus mainly on the Ordnance Center and School's change from a "fix forward" scheme to one that calls for a "replace forward" mindset. This single change, described in just a few words, may have the largest repercussions on how the Army maintains its combat power. It affects every other component of the Army maintenance organization in very significant ways. The Army has also made dramatic changes in the structure of all its units, not just support units. For example, each maneuver battalion has its own Forward Support Company (FSC) that provides nearly all support to that battalion by itself. Forward Support Battalions (FSB) have been replaced with Brigade

Support Battalions (BSB) with a very different support role. Entire support units have been eliminated while others have been stood up, if only with a headquarters and little else, to provide non-habitual, general support to divisions. CL IX parts are a significant part of the analysis because the Army will always rely on its heavy mechanized force to a large degree, even if for deterrence only. To be effective, a deterrent must always be ready for implementation or it ceases to be effective. Mechanized forces will always be heavily dependent on repair parts and the availability of these parts figures heavily into heavy unit readiness. The next section of the paper will present “easy fixes” or areas that can be made better without labeling the effort as transformational and with the resources already available to us. Finally, the paper will conclude with a determination of whether maintenance transformation efforts are more influenced by effectiveness or efficiency which will show what the true impetus for maintenance transformation is.

All analysis will include how changes in one area reverberate throughout the entire maintenance system in accordance with systems thinking. Most importantly, a determination of transformation success will be made backed by data, after action reports (AAR) from recent conflicts, and information compiled by numerous agencies that research and analyze the state of Army affairs. When looking at each of the areas of maintenance transformation, in conjunction with the analysis mentioned above, this paper will seek to determine the goal of transforming a particular aspect of the maintenance system, its plan to get to that goal and compare it to the tenets of General Systems Theory in an attempt to ascertain the coherence of the transformation plan. Many transformation initiatives have already begun, some are close to being finished in their implementation and some are still in the planning stages. Even though some transformation efforts are already underway or completed, it is not too late to make course corrections if less than

adequate conditions are found. The problem is not change itself, for change is ubiquitous.<sup>10</sup> The problem lies in managing change and shaping it to meet the desired ends, decreasing the unknown by analyzing effects of proposed changes and their possible unintended consequences.

The purpose of this paper is not to condemn Army transformation or support it, but to participate in the process. Many senior leaders encourage Soldiers at all levels and from all branches to speak out with their ideas on how to make transformation better. The understanding that transformation does not have an end but is a continuing effort, is vital to the success of transformation. The aspirations and expectations set by our leaders, both civilian and military are lofty and will be difficult to achieve. Without an honest analysis and debate, the process will become hollow and meaningless. Buy-in from the force must be attained. They are the implementers that have to make transformation work. Without their input, hard work and perseverance, transformation will remain much like the aforementioned vignette...an unrealized goal.

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<sup>10</sup> Gerald M. Weinberg, *An Introduction to General Systems Thinking* (New York: John Wiley and Sons, Inc., 1975), 2.



## II. GENERAL SYSTEMS THEORY

The United States Army is an organization of such size and scale that few other entities in the world rival it. The Army itself is a system that is made up of smaller systems, or sub-systems, while at the same time, a sub-system of a still superior system. Systems at all levels have leaders, managers, supervisors or controllers responsible for the efficient and/or effective operation of their particular system. The Chief of Staff of the Army is responsible for the entire Army, not only interested in the needs of his organization but also how it fits into the overall strategy of the United States. Subordinate leaders manage their own systems and strive to keep them running smoothly, working to attain the goals set for their organization while presumably, also taking into consideration their effects on other organizations in the Army. This holistic or systems perspective is required for any organization to survive. Recognizing the need for systems theory, applicable to many, if not all disciplines, led scientists to spend time and effort on developing and refining what is known today as General Systems Theory. It is important to have a basic understanding of General Systems Theory as well as its origins to see what benefits it provides to the resolution of problems and what issues motivated early systems theorists to refine a theory that had little influence in more traditional scientific disciplines.<sup>11</sup> This chapter will introduce General Systems Theory, explain the functions of stability, interaction, feedback and then briefly discuss complex systems. The chapter will end with a review of system survival. These sections will lay the groundwork for the following analysis of maintenance transformation.

### General Systems Introduction

Systems thinking existed as far back as the 1920s but did not attract much attention, as many scientists were slow to acknowledge the fact that their disciplines alone were not sufficient to deal with the problems or mysteries they encountered in their fields. Developments in many

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<sup>11</sup> Ludwig von Bertalanffy, *General Systems Theory. Revised Edition.* (New York: George Braziller, Inc., 1968), 11.

fields in the early parts of the 20<sup>th</sup> Century made the prospect of a systems approach more realizable. New thoughts in theoretical, epistemological and mathematical and other areas, while not thoroughly refined, allowed a new approach to solving problems encountered in many disciplines and continuously increased the feasibility of General Systems Theory.<sup>12</sup> In 1954, the Society for General Systems Research was organized to further the development of theoretical systems that were applicable to more than one of the traditional disciplines. Its major aims were to investigate the isomorphy<sup>13</sup> of concepts and laws in various fields and facilitate development of theoretical models in disciplines that lacked them. In doing so, the Society hoped to minimize the duplication of effort of different fields in developing theory by providing a venue for the communication of ideas among scientists from different specialties.<sup>14</sup> This was important because up to that time, the approach to science was very analytical and attempted to break up reality into ever-smaller units to isolate causal trains.<sup>15</sup>

This reductionist mindset paid little, if any heed to the interaction of elements in a system instead of in terms how they interact, not only with each other, but also with any other elements found in connected systems. It was not understood that reductionism was but one approach to understanding, one among many.<sup>16</sup> Reductionism was able to answer some questions presented to scientists, but not all. It was necessary to realize that there were other ways to explain phenomena, ways that did not attempt to simply reduce the components of an object or process to isolate its individual components. What general system theorists proposed instead of reductionism was perspectivism.<sup>17</sup> Perspectivism allowed for a more realistic approach to science. Perspectivism stresses the importance of a system's role in an environment. It also

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<sup>12</sup> Ibid., 11.

<sup>13</sup> Ibid., 33. Isomorphism is the similarities in organisms of different species or characteristics of different types. It speaks to the universality of certain systems theory tenets.

<sup>14</sup> Ibid., 15.

<sup>15</sup> Ibid., 45.

<sup>16</sup> Weinberg, 121.

<sup>17</sup> Bertalanffy, 49.

speaks to a system's purpose which changes in regard to the observer. One observer may see a system differently and therefore see a different system purpose. It is also significant when designing a system. A system designer must first determine the system purpose and then build the system to meet that desired output. His perspective, or point of view, will weigh heavily in the design of the system. The true systems thinker will always consider the interaction of the system with its environment to gain stability and not seek stability solely within the system. Instead of reducing everything to physics, system theorists strive to find the similarities in different models to ascertain laws or tenets that could be used to provide insight into all fields of study. They see systems thinking as an important means of controlling and instigating the transfer of principles from one field to another.<sup>18</sup> In essence, the early theorists saw systems thinking as a new discipline within itself; one that did not serve its own ends, but the ends of all fields of study.

With a basic understanding of why and how systems thinking came about, the next step is to see what benefits it offers in resolving issues. First and foremost, General System Theory aids in the identification and description of organizations. A basic problem that existed years ago, and still exists to a certain extent today, is having a general theory of organization.<sup>19</sup> General Systems Theory helps form the processes and creates a language that can identify the relationships between elements of a system and their nature. It can help describe the interactions or transfer of energy between elements, inputs, outputs and the types of feedback from systems. Systems thinking does not just apply to science in a laboratory or in experiments. It has an everyday utility that makes it suitable for practical application as well. For example, the problems that face society today are vast and complex. Pollution, crime, war, energy shortages and inflation are all

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<sup>18</sup> Ibid., 80.

<sup>19</sup> Ibid., 34.

issues that affect whole world. At times, they seem to be insurmountable.<sup>20</sup> If one understands the forces that bring these occurrences about, they will be much better suited in formulating a solution. An understanding of how different systems interact to bring about a certain event will aid in the choice of a measure to counter its undesired effects. Systems thinking will also help forecast the second and third order effects on the rest of the system. In the case of unemployment, for example, it would consider its impact on the rest of society.<sup>21</sup> Continuing advances in technology and the rate at which they occur has greatly increased the complexity of systems in the world today. Science and engineering serve as catalysts for change that were thought impossible just a few years ago. But just as in years past, the sciences have not been able to, or have not deemed it necessary, to allot sufficient resources and theory development to determine second and third order effects of the changes their “first order victories have produced.”<sup>22</sup> Because of the success science has enjoyed, a strong general systems approach is needed to help manage the complexity that scientific success has brought to society.<sup>23</sup> What follows are some examples of how systems thinking can establish the right mindset to manage complexity and understand the systems that exist today.

A system can be defined as “a collection of parts which interact with each other as a whole.”<sup>24</sup> Some definitions take a more poetic slant and state “a system is a way of looking at the world...a point of view.”<sup>25</sup> Both are correct but are enhanced when considered together. The prospect of a “point of view,” especially ones that do not coincide, make some people apprehensive. Acknowledging that there are multiple points of view means discrediting one’s own to a certain degree. This is unacceptable to many. The important lesson to take away from

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<sup>20</sup> Draper L. Kauffman, *Systems I: An Introduction to Systems Thinking* (St. Paul: Future Systems, Inc./TLH Associates, Inc.), 1980, ii.

<sup>21</sup> Ibid., ii.

<sup>22</sup> Weinberg, 2.

<sup>23</sup> Ibid., 3.

<sup>24</sup> Kauffman, 1.

<sup>25</sup> Weinberg, 52.

any definition of a system is the concept of organization and that there may be more than one way to organize something. Organization theory deals with analyzing complicated situations or systems and determining an effective means of dealing with them.<sup>26</sup> Organization entails many other things such as stability, feedback, interaction, etc., that will be addressed in the chapter on General Systems Theory. Draper L. Kaufmann, of Future Systems Inc., explains General Systems Theory in a way that does not require an extensive scientific background and education. Kaufmann states that “if something is made up of a number of parts and it does not matter how those parts are arranged, then we are dealing with a ‘heap’ and not a system.”<sup>27</sup> Heaps are essentially unchanged by any arrangement of its parts and adding to or taking away from the heap. One example is sand.<sup>28</sup> Organization is not required for heaps, as Kaufmann calls them, but is very important for a system. A system, with its organization and structure, is changed, usually dramatically, by taking away some of its components.<sup>29</sup> Its very ability to exist is probably risked by altering the parts contained within and their interactions. With the aforementioned definition of a system, the advantages of systems thinking should be considered. First, learning about new topics or systems will be easier. Instead of learning about each system or subject in isolation from all others, one will be able to identify characteristics of systems and apply them to their study of other systems, even ones that do not exactly follow the same pattern. This will be facilitated by a focus on interaction between system components. Secondly, complex problems and situations are easier to understand. A systems approach allows for a holistic perspective not only on a problematic situation, but also on the solution.<sup>30</sup> Systems thinking is conducive to formulating strategies, long term in nature, not just a short-term fix to get through the immediate issue. It presents options that otherwise may have gone undiscovered. Finally,

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<sup>26</sup> Mary Jo Hatch, *Organization Theory: Modern Symbolic and Postmodern Perspectives* (Oxford: Oxford University Press), 1997, 3.

<sup>27</sup> Kaufmann, 2.

<sup>28</sup> Ibid., 2.

<sup>29</sup> Ibid., 2.

<sup>30</sup> Ibid., ii.

systems thinking helps develop a comprehensive view of the system or area of interest, aiding in integrating previously separated bodies of knowledge and ideas.<sup>31</sup>

There are many criteria available to evaluate a system. It is important to determine which are the most relevant based on the purpose and characteristics of a system. To help determine the type of system, and therefore which criteria are best suited to evaluate it, it must be determined which general system laws apply. By their nature, general systems laws are conditional, in other words, applicable when certain conditions are met. Because of this, the term “law” is somewhat misleading. The term “law” connotes an ironclad statement of fact or unalterable sequence of events. An example of this is the First Law of Thermodynamics that states: “Total energy in a system is constant.”<sup>32</sup> Naturally, this law does not apply to open systems that have outputs, inputs and feedback that affect both. Open systems are ones that interact with their environment. Conversely, closed systems are ones that are isolated from their environment.<sup>33</sup>

The Army’s maintenance system, both legacy and transformational, is an open system that has a constantly fluctuating level of input (e.g. CL IX, manpower) and output expectations. Some would argue that because the maintenance system is merely a subset of the Department of Defense readiness, that there is a finite amount of potential resources to be applied and limited assets for them to be applied to, so the system would be closed. The word that negates this argument is “potential.” The mere fact that there is a choice of where energy, in this case resources, can be applied, leads to the fact that the Army’s maintenance system is an open one. Anyone that has been to a Materiel Readiness Review (MRR) or Materiel Management Review (MMR) knows the pain that can be associated with the statistics shown to the division leadership while explaining how resources were used most effectively to maintain acceptable readiness

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<sup>31</sup> Ibid., ii.

<sup>32</sup> Weinberg, 39.

<sup>33</sup> Bertalanffy, 39.

levels.<sup>34</sup> Unfortunately, many of the statistics are snapshots in time that do not allow for trend analysis. In many cases, the division leadership did not spend the time necessary to glean the most useful information from the statistics on the slides prior to the review because of schedule constraints or inclination. Snapshots in time are limited in their usefulness because of another general system's law, the Law of Medium Numbers. The Law of Medium Numbers states "For medium number systems, we can expect that large fluctuations, irregularities, and discrepancy with any theory will occur more or less regularly."<sup>35</sup> What this means is that a particularly low operational readiness rate may stem from a poor maintenance program or a combination of factors outside of the unit's control such as operational commitments and scarcity of certain high-demand, CL IX parts. The factors that led to an average must be analyzed and compared to past performance to establish a trend. Gerald M. Weinberg states "...randomness is the property that makes statistical calculations come out right."<sup>36</sup>

Unfortunately, this randomness exists in many cases because of the level of unknown information leaders have. Decreasing randomness moves information provided by a system from statistics to indicators. Indicators are not random. They allow for a measure of how a system designed for a specific purpose or goal is performing. Indicators delineate a delta between what the system was supposed to do and what it is actually doing. With this information, or feedback, in hand, a system can adjust itself to get closer to its optimum state. It is important to remember that general systems laws are not designed to yield answers. They will never be used for precise conclusions without first analyzing the insights they provide.<sup>37</sup> Knowing this reminds a system researcher to constantly check not just the raw data of a system, but also its implications. This now allows the researcher to determine the relevant characteristics to analyze. The aspects of a

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<sup>34</sup> An MRR/MMR is a session where the division's readiness data is shown to the division leadership and is normally chaired by the Assistant Division Commander-Support (ADC-S).

<sup>35</sup> Bertalanffy, 20.

<sup>36</sup> Weinberg, 17.

<sup>37</sup> Ibid., 41.

system that will be focused on in this discussion will be system stability, interaction of a system with its environment, and feedback. There are other aspects that will be discussed but these are the most pertinent to a discussion of the Army's maintenance system. Each of these characteristics will be used to analyze the sub-systems of the legacy and transformed maintenance system mentioned previously.

As mentioned earlier, many transformation initiatives are not complete or have even started. Every effort will be made to consider the intended purpose of a proposed transformational change based on the result of research, even if the transformation program has not been completed or initiated. This is one of the massive complications facing the Army in its effort to transform. The Army is too big to transform in all areas, all at once. Because of this, transformation has to be done piece-meal, whether by unit or process. Not all units can get new equipment all at the same time. Neither the industrial base of the United States nor the budget can handle this approach. Some units will still use the four level maintenance approach of the legacy maintenance system while others will have already moved to the two levels of maintenance and replace forward/repair rear model.<sup>38</sup> The schoolhouse cannot train all maintainers in the field and new recruits at once. Proposed transformation doctrine calls for multi-capable maintainers in order to implement the two-tiered maintenance model as well as the replace forward approach, which in turn affects CL IX repair part usage and requirements. As it should be, all aspects of transformation are inter-connected, designed to complement the others. Because of the phased implementation, the design of the timeline for transformation becomes as important as the transformation itself.

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<sup>38</sup> Replace and repair forward designate the maintenance done of certain components in the maintenance system. The legacy maintenance system uses more repair of components forward, in the brigade combat team area of operations, and the transformed maintenance system calls for increased component replacement forward.



## Stability

Stability, interaction and feedback were mentioned earlier as the system aspects most relevant to the discussion of Army maintenance system. To get the most out of this analysis, each must be detailed to a certain degree to facilitate discussion and establish the language to be used. Stability, the most important, overarching, and perhaps most misunderstood aspect, will be described first. Stability may be the most misunderstood because of its perception as being equal to a good aspect or its role in making a “good” system. A stable system is not necessarily a good system.<sup>39</sup> An example of this can be found in our world everyday. A system of government that has tyranny and ruthlessness as its foundations may be stable but is probably not a good system.<sup>40</sup> The point of view must also be specified to determine the goodness of a system. Many people point out the fact that Iraqis only have limited hours when electricity is available currently. This is true, however, only certain factions favored by Saddam Hussein had continuous electricity during his reign, while other factions not favored by him, had very little, if any power. Now that power is being distributed equally, the Sunnis, who were used to continuous electricity, no longer get a disproportionate share of the power and may think the new system is bad. The Shia however, who get a larger, albeit proportional, share of the electricity, may think that the new system, although unstable, is good. An unbiased outside observer could make the case that since more power is being produced overall, by some 270%, that the system is good.<sup>41</sup> This is somewhat simplistic as there are many factors that lead to good and/or stable governments but it serves to illustrate the point of perspective on the relative goodness of a system and how stability does not necessarily lead to goodness.

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<sup>39</sup> Weinberg, 233.

<sup>40</sup> Ibid., 233.

<sup>41</sup> The electricity example was from recent address to the School of Advanced Military studies and due to the non-attribution policy of the Advanced Military Studies Program, the source cannot be identified.

With this in mind, it is important to have a good working definition of stability that will support the discussion on systems. Stability is a relationship between a system and environment.<sup>42</sup> Only in a true closed system can absolute stability be achieved. The Army maintenance system, as mentioned above, is an open system, so that is where this discussion will focus. An open system has too much interaction with its environment to compensate for all the energy input into it. Looking for stability within a system in and of itself is counter-productive because there is no way to avoid the effect of the environment on an open system.<sup>43</sup> Some would try to preserve some notion of internal system stability in the concept of a linear system where a particular input changes something in the system by the exact same amount.<sup>44</sup> Once again, this does not correspond with the nature of the Army maintenance system so it does not apply. The input to the Army maintenance system can be magnified or lessened by construct and discipline of the system and those who manage it. For example, an unacceptable readiness rate of M1A1s caused by engine supply shortages can be dealt with in several ways. Hours of M1A1 operation could be decreased, thereby lowering the requirement of engines needed but without an adequate supply of repair parts or engines themselves, the problem may still exist. More mechanics can be assigned, thereby increasing the number of serviceable engines assuming sufficient CL IX stocks are available. The increase of mechanics will have a disproportionate positive effect. The more mechanics that are added will allow more shifts and decreased turn around time of serviceable engines thus increasing system stability.

Stable systems have ways of resisting change or undesired outputs.<sup>45</sup> Outputs themselves can be a great source of change or disturbance, affecting the input to the system and causing even greater change or disturbance. Poor quality work by the increased number of mechanics will decrease the mean time between engine repairs for example. This aspect will be further explained

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<sup>42</sup> Weinberg, 230.

<sup>43</sup> Ibid., 230.

<sup>44</sup> Ibid., 231.

<sup>45</sup> Kauffman, 2.

in the discussion on feedback. The more complex a system becomes, the more its stability depends on its flexibility in handling the myriad of possible inputs and situations caused by its environment.<sup>46</sup> This flexibility usually decreases the amount of predictability in a system due to the rapid responses necessary to adapt to a changing environment. This is of particular interest to the discussion on the transformation of the Army maintenance system. Both the legacy and the proposed Army maintenance systems are complex, although the legacy one is certainly more complex because it requires more management and course correction with increased CL IX usage and assets forward. This may seem to be a downfall of the legacy maintenance system, but in actuality, it is just the cost of doing business, business that requires expertise and a considerable amount of resources to achieve an elusive goal that is paramount to the success of the Army in its mission: acceptable operational readiness.

There are three parts to stability, two of which have been discussed. The system itself is one part, especially as it interacts with its environment, which is the second part. The third part is the critical limits of the system.<sup>47</sup> Critical limits are especially subject to the perspective of the observer. Where one observer may see a massive system failure, another may see a routine fluctuation or cycle within the system and recognizes that the system will correct itself. A familiar example of this is something that affects many people everyday; the stock market. It would be hard to imagine a more complex system than the world of finance and investment in the stock market. Many see a significant drop in share prices and fear losing all they have invested so they react by selling off their shares before they lose their entire investment. Others see an opportunity to get shares at a lower price and buy as much as they can. Both courses of action have their risks. Loss or gain in regard to stocks is not realized until the sale of the stock. The party that decided to dump their stock and cut their losses realizes that loss upon the sale. The party that bought more stock at the lower price may reap the benefits later if the stock rebounds.

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<sup>46</sup> Ibid., p. 36.

<sup>47</sup> Weinberg, 234.

This is where critical limits come in. If the system is flexible enough and corrects itself resulting in higher stock prices, the stock buyer wins. If the price drops so low and the company is dissolved, declares bankruptcy or is taken over, the stock becomes nearly worthless and the stock buyer loses. Knowing the critical limits of a system and increasing flexibility in a system to allow it to absorb more stress is vital when designing a system.

## Interaction

It has been established that stability in a system is dependent on how it interacts or interfaces with its environment or state. Interaction can be defined as the nature of the outputs and inputs of a system with its environment.<sup>48</sup> Interface and interaction are often used interchangeably. Interface can be seen as the place or component in the system where the interaction occurs. For the purposes of this discussion, the terms should be seen as synonymous. The term “boundary” as in system boundary is used by many system theorists but interface is a more appropriate term because it connotes a connection of the system with its environment and not just the limit where the system ends and the environment begins.<sup>49</sup> Objects can be seen to have boundaries and systems have interfaces or interactions with their environment. The example of the stock market can be used once again to illustrate this point. The stock market itself is the entire system with a myriad of interfaces. Investors are connected systems that interact by buying or selling shares. Corporations are another system that interacts with the stock market by its actions that make the stock more or less valuable. If the term boundary was used, the concept would be less accurate because it would speak more to the separation of the related systems as opposed to the areas of interaction between them. The Army maintenance system has multiple interfaces as well. The mechanics work on platforms that belong to a different unit. The supply support activity interfaces with the maintenance units and maintenance managers and leaders

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<sup>48</sup> Arlyn J. Melcher, *General Systems and Organizational Theory: Methodological Aspects* (Ohio: Kent State University Press, 1974), 146.

<sup>49</sup> Weinberg, 147.

should interface with all connected systems. The system design will allow for better interaction between related systems and the systems will complement each other. Too often, system designers and managers focus too much on the success of their own system and not how their systems can support related systems. They may even manage their systems to the detriment of others in the pursuit of their systems survival and prosperity.

This situation may be best described as the tragedy of the commons.<sup>50</sup> Complex systems contain many subsystems that may have goals that conflict with each other by design or management. “The Tragedy of the Commons” is an essay by the ecologist Garrett Hardin. The commons refers to the common pasture of medieval England and colonial America. “Common” in this essay meant that all members of a community were allowed to use the pasture free of charge. It was in the best interest of the individual to have as many cows as possible since the grazing was free. As more cows grazed, the pasture reached its critical limit when the grass was eaten down to nothing and only dirt remained. With the grass gone, the cows died and the village starved. It did no good for any one villager to keep the size of his herd down as he would just leave more grass for another villager’s cows, creating even more incentive for the other village to increase the size of his herd. The point of this story is that if each village made the decision that made the most sense for him individually, everyone would be worse off. If a viable system was designed and implemented, the number of cows (system input) would be regulated as it interfaced with the pasture (environment or related system) and the village as a whole would prosper. As can be seen in the example provided in “The Tragedy of the Commons,” the interaction between systems and its environment as well as connected systems must be given considerable thought when system design is undertaken.

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<sup>50</sup> Kaufmann, 3.

## Feedback

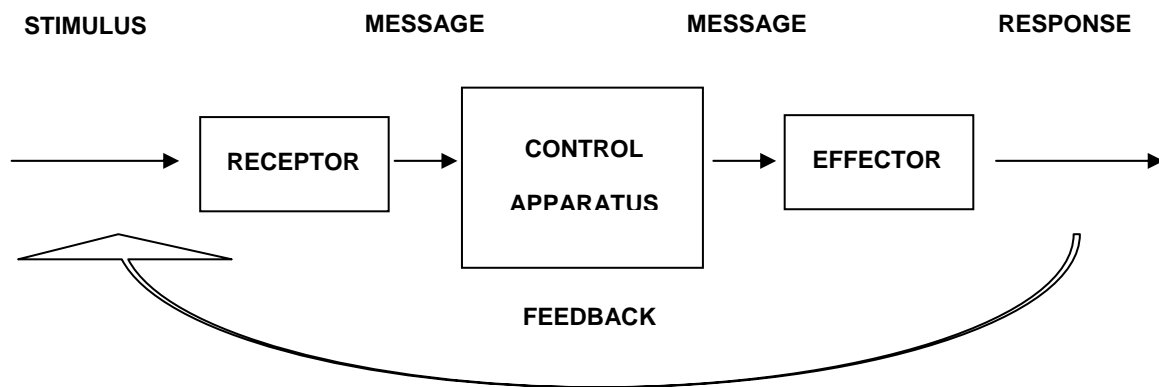
The next system characteristic to be discussed is that of feedback. Feedback can be defined as information about the output of the system that is fed back, or introduced, into the input side of the system.<sup>51</sup> Input and output are sources of interaction for a system. They also serve as feedback to the system and influence the system cycles and processes. An example of this is the game of basketball. A basketball team is comprised of players, each of which can be seen as a system, a system that is subordinate to another system, the team. It interacts with an opposing team, another system, on a basketball court, which is the environment. A player (system) receives input, such as the movement of other players on his team, placement and movement of the defense, the position of the goal, and other physical factors that will cause him to make certain decisions. These decisions trigger his muscles to carry out the prescribed movement, such as a dribble or pass, then the environment, comprised of other players (systems) react. The process begins again and repeats until the game is over. In the game of basketball, there is significant input that is not derived from the environment and is not dependent on space-time information. It can be a pre-designed play, an offensive or defensive scheme or any other plan formulated prior to the game. This provides stability to the team because they know what the other players of the team will be doing in a given situation.

This type of input can also be seen in the Army in the form of standard operating procedures (SOP). Installations and units establish local SOPs that establish how activities will be completed. These must comply with doctrine that comes in the form of Army regulations, field manuals and related material. SOPs and doctrine normalize the input and output the unit deals with and seeks to make feedback more conducive to system stability. Feedback mechanisms are closely integrated within a system and should be considered part of the system or else their usefulness is extremely limited. Feedback arrangements are widely used to achieve

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<sup>51</sup> Kauffman, 5.

stability in a system by automatically integrating changes in the environment caused not only by the system itself but by other systems that exist in the environment. If feedback is not connected to the system through some sort of control apparatus, then the information provided by the feedback mechanisms are unable to be used to achieve the desired end or allow the system to maintain its cyclical balance.<sup>52</sup> A representation of a simple feedback scheme is found below.



**Figure 1. Simple Feedback Scheme<sup>53</sup>**

Cybernetics, which is the control and communication of regulatory feedback, both in living organisms and man-made machines and combinations thereof, was introduced by Norbert Wiener to deal with the phenomena of feedback. The theory attempts to show that feedback mechanisms are the base of teleological or purposeful behavior in man-made machines and systems.<sup>54</sup> This is important because as an artificial and purposeful system, the Army maintenance system must have effective feedback mechanisms to maintain its ability to operate with varying and often unforeseen input from its environment and other systems. Feedback comes in two different forms, negative and positive. As their names imply, they are very different types of feedback and affect systems in very different, but not necessarily opposite ways.

<sup>52</sup> Bertalanffy, 43. The concept of a control apparatus is introduced by Bertalanffy on page 43 and expanded on thereafter by the author.

<sup>53</sup> Bertalanffy, 43.

<sup>54</sup> Ibid., 44. Teleology is the use of ultimate purpose or design to explain phenomena.

Negative feedback is feedback that cancels out or negates changes in a system that makes it deviate from its intended output or purpose.<sup>55</sup> Because of the pervasiveness of negative feedback loops in the systems found in the world, their role in systems is central to understanding systems theory. Examples of systems with negative feedback loops are thermostats, float valves, inventory management and ecological systems.<sup>56</sup> All of these systems aim at a target, usually fixed but not necessarily, and receive input that communicates the changes that have occurred that affect the system. The thermostat receives input regarding temperature of the environment and through the control apparatus, adjusts the system to compensate for the change. This of course, affects the system output, which may cause changes in the system itself, through the input the system receives from the environment. Any system that is going to survive has to have the ability to cope with change. All stable systems get this self-stabilizing ability from negative feedback loops.<sup>57</sup>

Because negative feedback is so pervasive, it creates similar behavior in different kinds of systems. It makes systems active, meaning they actively respond to changes. These changes normally require energy to compensate for and this is where inefficiency can get introduced into a system. Misdiagnosing a fault on a vehicle will cause the ordering, shipping, receiving and installation of the wrong part which is a massive expenditure of energy with no net benefit. Chronic misdiagnosis can cripple any maintenance program all by itself. Negative feedback is also found in loose systems. Loose systems have a flexibility that allows them to respond to changes. A repercussion of this is that system performance may fluctuate to a degree as the system corrects itself. As stated earlier, negative feedback does not prevent change. It simply responds to it and depending on the control apparatus and its aggressiveness, the system may over or under-react to the change. There is a price for this increased flexibility found in loose systems

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<sup>55</sup> Kauffman, 5.

<sup>56</sup> Ibid., 6.

<sup>57</sup> Ibid., 6.



which normally manifests itself in decreased predictability. Reaction time in a system with a negative feedback mechanism is an important consideration. It does not have to be fast or slow but just appropriate to the requirements and purpose of a system. In the earlier example of a misdiagnosed fault, the mechanic's first line supervisor could correct the ordering of the wrong part by verifying the fault. For this to be most effective the correction would have to occur before the Unit Level Logistics System-Ground (ULLS-G) or Standard Army Maintenance System-1 (SAMS-1) clerk processed the next requisition batch. Some problems or changes can not be dealt with no matter how fast the reaction time is. This is a situation where the characteristic of anticipation is required. The system's feedback mechanism reacts to warnings of changes as opposed to the actual changes themselves. This is similar to a vehicle operator noticing that the vehicle thermostat shows the vehicle's engine approaching catastrophic temperatures and takes preventative measures before the engine overheats and fails. Reaction time is still important, but reaction to the warnings of trouble or changes is the key because in certain situations, once the change has occurred, there is no way to remedy the situation no matter how fast the system responds.<sup>58</sup> When trying to adjust or modify how a system reacts to specified changes, it is important to understand where the negative feedback loops in the system are and how they work. This effort may lead to better results than scrapping the system entirely and investing time and resources in designing a new system.

Negative feedback is not the only feedback scheme found in a system. There is also positive feedback. Positive feedback differs from negative feedback in that it amplifies or adds to any disturbance in a system.<sup>59</sup> As already discussed, negative feedback works to negate changes that occur in a system, trying to maintain a steady state within the system. It must be remembered that negative and positive are not statements describing the goodness or harmfulness of change, but the nature of the change itself. The type of feedback is determined by how it deals with

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<sup>58</sup> Ibid., 13-16.

<sup>59</sup> Ibid., 20.

changes in a system. A simple example of positive feedback is interest returned on money in a savings account. A savings account that returns interest on money deposited is like a money amplifier. Once you put the money in the “system” or account, it will accrue interest which is added to principle. This new larger principle in turn generates even more interest. Change is amplified in the system and re-introduced to begin the cycle again.<sup>60</sup> Positive feedback is not as prevalent in systems, especially man-made ones, because systems are usually designed to produce a certain output or cycle and efforts are made to maintain stability and not amplify changes within the system. Accordingly, positive feedback does not play as large a role in the Army’s maintenance system as negative feedback. There are certain areas where positive feedback plays an important role and must be considered or system effectiveness is severely degraded.

A phrase often heard is “information is power.” This is as true in the military as anywhere else, maybe even more so. This is where positive feedback plays an important role in any system. Once knowledge is attained, it leads to the further attainment of knowledge in greater amounts. Before the written word, knowledge was gained through interaction with the environment or other individuals.<sup>61</sup> The amount of knowledge was usually limited to the actual experience of the individual. When the written word was developed, people’s thoughts and ideas could be recorded and distributed in increasingly larger areas of the population, even more so with the invention of inexpensive means of reproduction.<sup>62</sup> As literacy became more commonplace, the amount of knowledge available for study and research became overwhelming, especially without a system that is able to sort and prioritize the information to determine relevance and worth.<sup>63</sup> Knowledge or information management is vital to successful military operations of any type. The advances in technology have allowed Army readiness managers to track the exact locations of CL IX parts in the supply chain, thousands of job orders from non-

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<sup>60</sup> Ibid., 21.

<sup>61</sup> Ibid., 22.

<sup>62</sup> Ibid., 23.

<sup>63</sup> Ibid., 23.

contiguous areas and the storage of massive amounts of knowledge gained from other's experience. As technology advances, so does the complexity of the equipment used by the Army and other services, which requires even more knowledge and expertise to maintain at acceptable operational readiness levels. Being able to store, review, analyze, query and modify this massive amount of information almost instantly is required or else the maintenance system will become less effective if not paralyzed.

Realizing the impact of positive feedback and its effect on information, among other things, is essential to managing the Army maintenance system. There are many innovations that allow for accessing well organized information in a timely manner for Army maintainers. One is the electronic technical manual (ETM). This allows the mechanic to have access to volumes of information in a relatively small computer terminal. Electronic technical manuals (ETM) greatly reduce knowledge management efforts by automatically categorizing and sending pertinent information to databases that store it for immediate or future review. Transformation efforts have led to the development of sensors on combat platforms that continuously monitor the status of the vehicle and send the information to readiness managers. It is near-real time and precludes the requirement of sorting through reams of reports from various sources. This information is also valuable for future operations because others can look for data from operations and exercises under similar conditions to aid in the forecasting of potential shortfalls. Positive feedback of this sort also contributes to system learning.<sup>64</sup> As computers or managers gain more information, better courses of action will be selected for future operations because of a larger data set which allows better prediction of system output.

Many systems, like the Army maintenance system, have both negative and positive feedback loops.<sup>65</sup> When both positive and negative feedback loops exist in a system, the nature of their combined effect must be determined and modified if necessary for optimum system

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<sup>64</sup> Bertalanffy, 150.

<sup>65</sup> Kaufmann, 27.

efficacy. Inherently, the different types of feedback work against one another.<sup>66</sup> Kaufmann states, “Generally speaking, the point at which the positive forces and negative forces balance each other is the point the system will go back to, time after time, after being disturbed by some change in its environment.”<sup>67</sup> Identifying the positive and negative feedback loops is also important because it allows the system manager or observer to determine if the change or disturbance in the system will have a temporary effect or a lasting effect on the system. Kauffman goes on to say, “Essentially, any change-no matter how big-which does not change the important positive and negative feedback loops, will only be temporary...At the same time, any change-no matter how indirect or small it seems-which affects the relationship between the plus and minus loops is going to alter the long-term behavior of the system.”<sup>68</sup> Returning to the discussion of positive feedback and its role in information management, a problem arises in regard to complex systems; distortion of feedback.<sup>69</sup> Complex systems, which will be described later, depend on information to control the behavior of their components, or subsystems. This may, especially in man-made systems in which human interaction is required, create an incentive for sub-systems to lie or distort feedback in an effort to change the feedback into their subsystem. Anyone who has attended an MRR or MMR knows that there is a fair amount of “feedback distortion” to the division leadership in the explanation of why they did not meet Department of the Army established readiness levels on mission critical vehicle fleets. The subjective nature of certain Unit Status Report (USR) input can also create feedback distortion as the unit commander tries to explain lower than desired readiness levels in personnel or equipment. Feedback distortion may cause complex systems to spend a great deal of effort trying to identify and prevent distortion. This can be done by several methods. The system can attempt to verify information validity through other channels, make the information harder to distort or

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<sup>66</sup> Ibid, 25.

<sup>67</sup> Ibid., 27.

<sup>68</sup> Ibid., 27.

<sup>69</sup> Ibid., 36.

bias by making information requirements more objective, or instituting severe penalties that discourage information distortion. The constant need to preserve the integrity of information a system receives only adds to the effort the system must exert to maintain its effectiveness. This stresses the system even more, possibly causing it to hit its critical limit and collapse.<sup>70</sup>

## Complex Systems

Since the Army maintenance system is a complex one, a clear idea of the requirements and characteristics of complex systems is important. Kaufmann discusses characteristics of complex systems and how these characteristics differentiate complex systems from simple systems in their organization, requirements, benefits and disadvantages.<sup>71</sup> Stability has already been described as the relationship between a system and its environment. Complex systems are, in turn, self-stabilizing in that they can return themselves to a desired posture despite changes in the environment. This requires a great number of negative feedback loops able to detect, analyze and act on environmental input to keep the system within a desired operational range. This range or desired output shows that a complex system is goal-seeking or purposeful.<sup>72</sup> This is especially true for man-made systems as some argue that biological systems are not goal-seeking but simply follow a pre-determined course. Since someone made a system, it must have a purpose or desired output and the fact that the system was made allows it to be modified. In striving to achieve its goal, a system may follow a program or procedure that has been determined to optimize performance.<sup>73</sup> Opening a maintenance work request in the United States Army has a prescribed set of steps required and any deviation from the established procedure will decrease the performance of the system. Of course, blindly following a prescribed procedure does not always produce the best results, but following guidelines established to allow different sub-systems to

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<sup>70</sup> Weinberg, 255.

<sup>71</sup> Kaufmann, 32.

<sup>72</sup> Ibid., 29.

<sup>73</sup> Ibid., 32.

work together is important to the health of the entire system. Empowering sub-systems to modify the guidelines and reorganize themselves, with the ability to discern the effects on related systems, greatly increases the flexibility of a system and will usually improve its output.<sup>74</sup>

Reorganization is often the result of a system learning from past experiences and changing the prescribed methods, either permanently or just to resolve a unique situation. Kauffman calls this characteristic self-reprogramming.<sup>75</sup> Kaufmann also states that as a system becomes more complex, it may even change the goal of the system itself because of the changed environment or system requirements. This self-programming is caused by the system gaining insight, allowing it to anticipate changes and their effects even if the system has not experienced them before.<sup>76</sup>

Greater complexity in a system creates both advantages and disadvantages. Complex systems are able to process more information, interact with their environment more, anticipate changes in the environment, learn and re-program themselves, be more flexible which allows them to operate effectively in a greater number of different situations.<sup>77</sup> More complexity also leads to more energy and resources being spent on information processing and gathering and normally more sub-systems to maintain, supervise and verify feedback from. Every increase in complexity has an associated cost and unnecessary additions to a system will just decrease the effectiveness of a system without an accompanying benefit.<sup>78</sup> This leads to the final section of General Systems Theory which deals with system survival.

## System Survival

In *An Introduction to General Systems Thinking*, Gerald M. Weinberg states that “systems we are accustomed to seeing are systems that have been *selected* from all systems of the

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<sup>74</sup> Ibid, 31.

<sup>75</sup> Ibid., 30.

<sup>76</sup> Ibid., 29-32.

<sup>77</sup> Ibid., 32.

<sup>78</sup> Ibid., 32.

past; they are the best ‘survivors’.”<sup>79</sup> This statement has inherent issues when looking at man-made systems, such as the Army maintenance system, which is also an open system. Being designed and created by man, a system can be reinforced with energy or resources to compensate for its ineffectiveness. In other words, a system can survive not on its own merits but by simply applying more resources resulting in higher costs.

Systems are thoroughly manmade....When we include a given relation in a system, or omit it, we may do well or ill; but such an inclusion creates no truth, and such omission indicates no falsity. The justification for one’s procedure, in this respect, is purely pragmatic; it depends upon the relevance of what is included or omitted to the purposes which the system is designed to satisfy.<sup>80</sup>

The Army is in a good position to transform its maintenance system into one that produces the desired output with the least amount of resources. Any maintenance system can be made to work by continuing to pour resources into it, but it must be determined if it could be done more effectively even if the initial costs are higher. Both the legacy and the proposed maintenance system require continuous input of resources to maintain stability. Which requires the least? Which uses the resources most effectively? Which is the most flexible and will survive in the widest array of possible situations? These and other related questions must be asked when designing the new Army maintenance system. One constant reality in any system, maintenance or otherwise, will be time. The passing of time cannot be stopped nor can the ineffective use of it be recouped once it passes. As time passes, equipment failures will occur. What follows is an analysis of how the Army proposes to transform its maintenance system and if it will be able to support the Army in its current and future conflicts.

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<sup>79</sup> Weinberg, 236-237.

<sup>80</sup> Ibid, 61.

### III. ARMY MAINTENANCE SYSTEM TRANSFORMATION

In the abstract of his United States Army War College monograph, LTC Victor Maccagnan states, "...if logistics transformation has not occurred or is stalled, the rest of the force will not be able to transform successfully."<sup>81</sup> This statement explains very succinctly and effectively the importance of logistics transformation. Every other part of the Army could transform very successfully, but without a successful logistics transformation, the whole process is bound to fail. Narrowing the scope to maintenance transformation, it is seen that it plays a similarly important role itself in logistics transformation because of the interaction the maintenance system has with other logistics systems. Transformation, as it is now known, is not something new. The first official use of the term "transformation" is often attributed to the document *Joint Vision 2010* in the following quote:

Enhanced command and control, and much improved intelligence, along with other applications of new technology will transform the traditional functions of maneuver, strike, protection, and logistics. These transformations will be so powerful that they become, in effect, new operational concepts: **dominant maneuver; precision engagement; full dimensional protection; and focused logistics. These operational concepts will provide our forces with a new conceptual framework.**<sup>82</sup> (Original bolding left in place)

A need for change in the military was recognized long before the attacks of 11 September 2001. The Cold War was over and the two major theater war (MTW) construct was soon replaced by the 1-4-2-1 construct calling for the United States military to defend the United States domestically while being able to deter aggression in four specific regions, simultaneously combat aggression in two of these regions and decisively win one of these two conflicts. The tragedy of 11 September 2001 led the Defense Department to refine the 1-4-2-1 strategy and strive to continue transformation of the armed forces while simultaneously conducting two campaigns in

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<sup>81</sup> Victor Maccagnan, "*Logistics Transformation-Restarting a Stalled Process*" (monograph, United States Army War College, 2004), v.

<sup>82</sup> Office of the Chairman of the Joint Chiefs of Staff, *Joint Vision 2010* [manual on-line] (Washington, D.C.: Department of the Army, 1996, accessed 20 November 2005); available from <http://www.dtic.mil/jv2010/jv2010.pdf>; Internet.



the Global War on Terrorism (GWOT). The need to make forces more agile, deployable, lethal and sustainable was determined to be critical in shaping United States armed forces for current and future conflict. These conflicts were forecasted to involve widespread deployment of forces of differing capabilities around the world to fight an enemy not in uniform and often hidden in urban settings waiting for the opportunity to conduct unconventional warfare.<sup>83</sup> The advent of new capabilities and the challenge of “skipping a generation of technology” brought many options to the table when designing the transformed force.<sup>84</sup> At that time, the force was deemed too heavy, cumbersome and expensive to handle such a campaign and designs for a more adaptable force were soon drawn up. As was mentioned in the Joint Vision 2010 excerpt above, logistics was included in the early thinking about transformation but was often sidelined as transformational concepts were tested.

In March 1997, the first major integrated experimentation with transformational concepts was held as part of the Force XXI Advanced Warfighting Experiment at the National Training Center (NTC). Logistics concepts did not only go untested but were not even sufficiently developed because serious discussion about logistics transformation did not even start until mid-1998, a full seven years from what many believe to be the inception of transformation.<sup>85</sup> Focused Logistics, as introduced and described in Joint Vision 2010, had not been developed to the point of being tested in exercises much less being fielded to the force as a way to realize transformed logistics.<sup>86</sup> As a result, logistics as an enabler and combat multiplier was deemed unsatisfactory. To meet the needs of the new force and its accompanying conceptual template, logistics had to become more deployable, have a smaller footprint enabled through Combat Service Support

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<sup>83</sup> Office of the Deputy Chief of Staff, Operations, United States Army, Army Transformation Office, *2004 Army Transformation Roadmap*, Department of the Army, July, 2004, 1-2.

<sup>84</sup> United States Congress, House of Representatives, Committee on Armed Services, *House Armed Services Committee*, United States Government Printing Office, Superintendent of Documents, Congressional Sales Office, 1999, 303.

<sup>85</sup> Macagnan, 4.

<sup>86</sup> Macagnan, 5.

(CSS) reachback, be modular, adaptable, flexible and cost effective. Many visions existed in respect to how logistics should transform: Department of Defense, Army, Joint and CASCOM all had views on how transformation should be executed and these views were often disjointed and out of synch with others.<sup>87</sup> An example of this can be seen when the Army did not completely mirror the joint concept of Focused Logistics as defined by the six joint tenets of transformation framework. It failed to include Joint Theater Logistics Command and Control, multi-national logistics and joint health services support.<sup>88</sup>

With this understanding of the roots of recent transformational efforts, the discussion will now move to maintenance transformation specifically. As mentioned in the introduction, the tenets of maintenance transformation examined in this paper are the multi-capable maintainer, doctrinal maintenance foundations, organization and structure and CL IX repair parts and the impact of transformational changes on CL IX. For each tenet, transformational changes will be described; historical data will be analyzed and general systems principles will be used to aid in determining the level of success transformation has achieved up to this point in each.

## **Multi-Capable Maintainer**

A central precept to maintenance transformation efforts is the multi-capable maintainer (MCM). The multi-capable maintainer is a combining of organizational level turret and hull repair with some selected on-system tasks formerly allocated to direct support (DS) level of maintenance.<sup>89</sup> The MCM is designed to work in conjunction with other transformation efforts such as the two level maintenance system and logistic unit restructuring. The MCM also aided the Army in its military occupational specialty (MOS) consolidation efforts by combining many maintenance MOSs together. As a result of these MOS consolidations, achieved in large part

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<sup>87</sup> Macaggnan, 8.

<sup>88</sup> Macaggnan, 6.

<sup>89</sup> Ordnance Center and School, United States Army, *Army Maintenance Transformation Implementation Plan*, Department of the Army, 2004, 7.

through the advent of the MCM, the Ordnance Corps' enlisted MOS structure was reduced from 43 to 35 MOSs. MCMs evolved from the use of forward support companies (FSC) to support units undergoing Force XXI concept implementation in 1996.<sup>90</sup> These changes were intended to combine organizational and selected DS maintenance capability into a "one-stop" maintenance activity which is known as the FSC. As will be seen in the organization and structure portion of the paper, this is no real innovation. This one-stop model has existed for years in the form of the maintenance support team which conducts the vast majority of DS maintenance for Army of Excellence (AoE) brigade combat team. The only things that have changed are where the mechanics are assigned, their ability to be surged to priority requirements, and the tasks they are officially allowed to perform.

MCM brings up notions of a "super-mechanic" capable of both DS and organizational levels of maintenance. Not only is this untrue from a training perspective but also from a resource perspective. MCM will only be resourced and trained to do "selected" DS tasks.<sup>91</sup> Feedback was described in the section on General System Theory as the output of a system being fed back into the system as input. The control apparatus then interprets the input and sends instructions to the effector in reaction to, or anticipation of an undesired input. AoE mechanics, that were more or less trained according to what maintenance level they would be assigned to, were unable to fully perform their duty as a vehicle mechanic fresh from advanced individual training (AIT). This does not reflect poorly on the Ordnance Soldier as their fields are very technical and the skills involved require years to master. Nonetheless, it took several months or more before AoE maintainers were able to perform even basic repairs independent of constant supervision. Increasing the scope of the requirements for the MCM only exacerbates this problem.

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<sup>90</sup> LTC John Kearney, "MOS Consolidations, A Step In Transformation," *Ordnance Magazine*, Spring 2005, 1.

<sup>91</sup> Ordnance Center and School, United States Army, *Army Maintenance Transformation Implementation Plan*, Department of the Army, 2004, 7.

The point is that the MCM will not have the capability to affect changes to their systems demanded by their control apparatus. This is true for two reasons. First, they will by design of the two level maintenance system, be trained to replace components and not repair them. This lack of capability will result from the way maintenance units are equipped (e.g. tools and diagnostic test sets), trained and manned. This will make itself more apparent as AoE mechanics leave the Army with their wealth of institutional knowledge. If the current trend is extended, a mechanic in the Army ten years from now will be very different from the mechanic of today. Transformation advocates will say that this is the goal of transformation. The unfortunate part is that the mechanic of ten years from now will not have the knowledge base, resources or tools to do what his predecessor did. A simple example will illustrate this point. The DS mechanic portion in the replacement of a M2A2/3 Bradley Fighting Vehicle transmission is very limited. So much so that the average DS mechanic is unable to conduct or direct the replacement of a M2A2/3 transmission from start to finish unless he has been exposed to special training or experience. Because of this, many DS maintenance units make an effort to train their mechanics in organizational tasks because part of their mission is to provide back up organizational maintenance to supported units.

The second reason is closely linked with the first in that any lack of CL IX parts significantly reduces the stability of the system. This is true today as well, but today's mechanic has the test sets, knowledge and most importantly, experience to negate undesired changes in their system. This capability comes from the fact that current DS maintenance units are equipped with diagnostic tests sets such as the Direct Support Electronic Test Set (DSESTS). DSESTS will also be part of the transformed maintenance system but they will be located much farther back in the maintenance system in what is termed sustainment level maintenance. The forward (what is called divisional today) MCM will not have access to or experience on diagnostic test equipment of this type. Because of the continuous development of maintenance doctrine, it is unclear what skills the maintainers at the sustainment level maintenance units will have. What is

known however, is that they will not as a rule be located forward and their primary mission is component repair. This places their skills farther away from where it really counts, the combat platform.

Training of the MCM is another important consideration, especially in consideration of the time spent in advanced individual training (AIT). Rightly so, the Ordnance Soldiers coming out of Aberdeen Proving Ground are getting the best combat training ever experienced by the Ordnance Corps at the entry level. Initial-entry Ordnance Soldiers are trained in 39 Warrior core tasks and nine battle drills.<sup>92</sup> This long overdue change to Ordnance Soldier training is a direct result of the overall Army transformational effort to prepare Soldiers for the contemporary operational environment (COE). Training Soldiers to be warriors, no matter what their MOS is, is the most important aspect of their introduction into the Army. What must be determined is if this new emphasis on warrior training, combined with the increased scope of the MCM, is compensated for with additional training time during AIT. If a Soldier is required to learn more skill sets within the same time frame, their grasp of these important skills will be even less complete. As mentioned above, legacy mechanics coming from AIT were not capable of conducting maintenance independent of close supervision. Without a substantial increase in time allotted to technical training during AIT, the additional responsibilities added with the MCM concept, combined with the increased emphasis on warrior task training, will make this deficiency even more pronounced.

Mechanic's capabilities are shaped more by their experience than their initial entry training. As previously described, the two level maintenance system has all off-system component repair being done at the sustainment maintenance level. Off-system maintenance will be conducted by combat repair companies (CRC), which will be reorganized from general

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<sup>92</sup> Major General Vincent E. Boles, Lecture to Command and General Staff Officer Course Students, Fort Leavenworth, KS, 7 December 2005.

support (GS) maintenance companies.<sup>93</sup> Furthermore, all CRCs will be in the reserve component.<sup>94</sup> What this means is that component repair expertise will migrate out of the active component and into reserve component units. Additionally, sustainment maintenance may be done completely by contract resulting in a total loss of uniformed personnel expertise in component repair.<sup>95</sup> Contract maintenance has become the panacea for maintenance shortfalls in the Army and as a result, the Army becomes increasingly reliant on contract maintenance. This poses many obvious concerns such as contractor accountability and availability, especially in combat zones. Currently contract maintenance conducts scheduled and unscheduled maintenance throughout the Army, in garrison and deployed. The argument for contract maintenance is that it provides the necessary expertise (which could be taken to mean that this expertise is lacking in uniformed personnel) more affordably than could be achieved than by training uniformed personnel. It is also believed that contract maintenance can be procured quickly and respond when needed to remedy a maintenance shortfall.

It is true that contractors bring a valuable capability to the Army. They are often retired maintenance personnel that have years of experience maintaining Army equipment. Sometimes they are specially trained technicians that are authorized by equipment manufacturers to conduct repairs on warranty equipment. Application of materiel work orders, new equipment training and training update sessions are all jobs well suited to contractors. If sponsored by equipment manufacturers, contractors can often procure CL IX parts that are difficult to obtain through Army supply channels. With that stated, contractors pose many challenges as well. They cannot be held accountable for their work to the degree that uniformed personnel can be by the Army

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<sup>93</sup> Major General Mitchell H. Stevenson, *Army Maintenance Transformation* [document on-line] (Department of the Army, 2002, accessed 30 January 2006); available from <http://www.almc.army.mil/alog/issues/SepOct02/MS838.htm>; Internet. There are discrepancies with other sources that say there are four CRCs in the active component but the information that was the most current was used in the monograph.

<sup>94</sup> Major General Vincent E. Boles, Lecture to Command and General Staff Officer Course Students, Fort Leavenworth, KS, 11 August 2005.

<sup>95</sup> Department of the Army, Washington D.C., *Army Maintenance Transformation*, signed by LTG Charles S. Mahan, Army Deputy Chief of Staff, G-4, 4 March 2003.

chain of command. Accountability of contractors is also often problematic. There are several accounts of contractor numbers in the Operation Iraqi Freedom area of responsibility (AOR) that far exceed the number being reported.<sup>96</sup> With 52,000 reported contractors in Iraq, this is a serious fiscal problem.<sup>97</sup> Security of contractors and the requirements for travel to and within the AOR is sometimes unclear. Contractor technical skills are sometimes unknown. The Army normally relies on the contracted company to certify the technicians it will use to fulfill its contractual obligations. This all means that as Army maintainers lose the ability to facilitate repairs on components, either through training or lack of resources such as tools or CL IX, reliance on contract maintenance will increase exponentially.

MCMs could be a huge asset to the Army maintenance system but not in a stand-alone capacity. They must be properly trained from their entry into the Army and throughout their career as new technologies and equipment become available. They must be resourced with a staggering amount of CL IX parts that allows for continuous replacement of components which are then sent rearward for repair or other disposition if irreparable. They are a component to a system, and as such, they interact with other components, or sub-systems, in the system. A properly resourced MCM would contribute a great amount of stability to a system. It would have direct interaction with related systems (supported unit, CL IX stocks) and finely tuned negative feedback mechanisms. What it wouldn't have however is flexibility and adaptability. If CL IX stocks cannot immediately supply the required part, there would be little recourse for the MCM. This lack of flexibility makes the system very rigid with low critical limits. As the maintenance system approaches this critical limit, operational readiness declines. When the critical limit is hit and passed, the rate of decline exponentially increases and could possibly result in system failure.

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<sup>96</sup> Department of the Army, Tank-Automotive and Armaments Command, Memorandum for Record, *Meeting Minutes "Kuwait Support"*, POC listed as CW4 Cushman, 16 January 2003. Received as a result of a research request from CALL. Available upon request from author.

<sup>97</sup> Major General Vincent E. Boles, Lecture to Command and General Staff Officer Course Students, Fort Leavenworth, KS, 7 December 2005.

The shortcomings of the MCM become even more pronounced when combined with the conceptual foundation of maintenance transformation.

## **Conceptual foundation**

Doctrine is very important to the United States Army. Even though the Army is not unquestioningly bound to it, doctrine lays out a method of conducting operations that allows for predictability and is compatible with other systems in the Army. Just a few words can have a very significant impact on the success or failure of Army operations. In reference to Army maintenance transformation, perhaps the largest single change in how business will be done can be described thusly; replace forward versus repair forward. This is a significant break from the traditional approach to maintenance and as such, will be the focus of this section. All maintenance related doctrine is affected by this reversal of policy. It changes how units will be manned and organized, how CL IX will be managed and how maintenance personnel will be trained and employed. It comprises what could be called the “system logic” of the Army maintenance system. It determines the teleology of the sub-systems in the Army maintenance system as well as the capabilities that will be given to each node. The goal of replace forward is to increase the rate of combat power regeneration and decrease the logistics footprint in forward areas. In other words, money could be saved by requiring less materiel and logistics force structure forward. Replace forward is very tightly bound to the other tenets of Army maintenance system transformation. It is conducted by an MCM, specifically trained to conduct component replacement. It is placed in a two-level maintenance methodology that requires component replacement by removing assets that would facilitate repairs forward. As many ramifications of the replace forward approach were discussed in the previous section, a brief synopsis how it fits into the Army maintenance system transformation will be presented for clarification.

The execution of maintenance tasks represents how and where the MCM interacts with the maintenance system. With the replace forward approach, combined with the MCM and two



level maintenance system, this interaction takes place in the forward area of operation, theoretically as far forward as AoE DS maintenance is conducted. The difference is the level of repair that can be affected forward. FSCs are multi-functional support companies embedded into supported units. Nearly all maintenance conducted for that supported unit will be done forward by the FSC, less any that is done by the base maintenance company of the BSB. This looks ideal at first look. What begins to make this approach look less optimum is the dependency on CL IX that develops as components are replaced instead of repaired such as the AoE FSB was formerly capable of doing. Direct Support (DS) Plus type capability is one example where such component repair was completed in the AoE maintenance system. DS Plus was an out-of-hide capability enhancement where 63H (tracked vehicle repair) Soldiers would attend a several month training program, normally resourced and located at the Main Support Battalion (MSB), to increase their knowledge of repairing the AGT 1500 engine, the engine of the M1 series tank. Mechanics from the FSB were selected to attend this training and received the best hands on training possible. The DS Plus training program is an excellent example of how contractors can support Army maintenance as DS Plus was often taught, if not led, by civilian contractors.

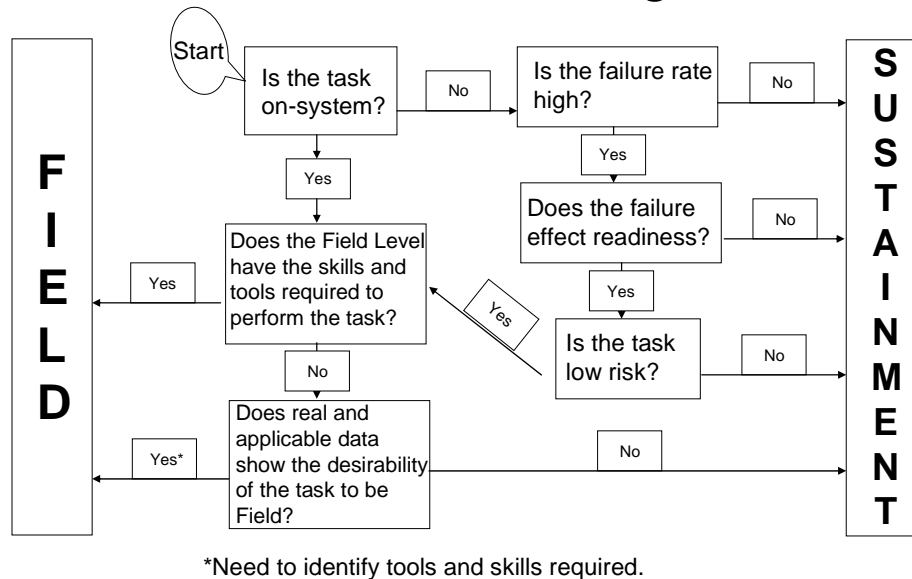
The DS Plus program was not standardized across the Army but always increased a division's capability to maintain the vital M1 fleet. This was done by repairing full up power packs (FUPP) with in the division and returning them to the supply system as a repairable exchange item or repair and return to user. This greatly decreased the reliability on the CL IX system by increasing the flexibility of the maintenance system through alternate means of serviceable FUPP components. This was one capability that was never idle, unlike many Army assets in a garrison environment. If production was not geared toward filling a supported unit requirement, it focused on maintaining the division supply of FUPPs and operational readiness floats (ORF). Though DS Plus type maintenance could not be done in any environment because of the need to work in a relatively dust and dirt free area, it was certainly deployable and often has been in its existence. Not only will the division lose this DS Plus capability, but it will lose

many of the normal DS tasks that were formerly performed. Line replaceable unit (LRU) repair will be affected in much the same manner. DSESTS capability will probably migrate to the sustainment level of maintenance which will severely restrict the mechanics in the BCT to facilitate on-site repair of LRUs which often require a simple replacement of circuit cards. LRUs should not have to travel to the sustainment level of maintenance, located far from the combat platform, to get a circuit card exchanged. It is important to remember that field maintenance is the combination of organizational maintenance and only selected DS tasks. Under the transformed maintenance system and its replace forward approach, once a component is determined faulty, it will be replaced with a component from the BSB authorized stockage list (ASL) and then sent to sustainment maintenance for repair and return to supply system or disposition if irreparable. Movement of CL IX on the battlefield is already problematic and the negative feedback mechanism comprised of waiting for the component to be prepared for movement, transported to the nearest sustainment maintenance facility, repaired or coded irreparable and returned to the supply system does not provide adequate flexibility. The interaction of the MCM with its environment will also be severely degraded because precise component fault diagnosis will not be conducted until the component reaches sustainment level maintenance. This limits the ability of MCMs and their supervisors to determine negative maintenance trends and appropriate solutions that may be specific to the unit they support of the conditions in which the equipment is performing.

The replace forward concept is not doomed to failure and offers many possible advantages over the repair forward model. In nearly every case imaginable, it would be quicker and less resource intensive to simply replace faulty components vice repairing them which requires more tools, test equipment and manpower. What replace forward does require is considerably more CL IX components ready for issue at any given time. It also requires increased transportation assets to move larger components vice smaller replacement parts, many of which are stocked at the organizational motor pools and DS level in the form of prescribed

load list (PLL) items, shop stock and bench stock. Transportation platforms will cube out much faster when carrying larger items versus smaller items that can be configured many different ways to maximize space utilization. With the focus of ASL composition being more dollar and cost oriented rather than requirement based, it is unlikely that the Army leadership will opt for a substantial increase in funding to provide the necessary CL IX to make the repair forward approach work. CL IX implications regarding Army maintenance system transportation will be discussed more thoroughly later in the paper. As stated earlier, one of the aims of transformation is to reduce the logistics footprint in forward units. Increasing transportation platforms is in direct opposition to this requirement and is also unlikely to be resourced. In the AoE maintenance system, maintainers are already under-resourced and must use innovative methods and creative thinking to maintain acceptable operational readiness rates for this high OPTEMPO Army. Taking away the tools that allow this innovation reduce the already perilously low critical limits on the maintenance system and may cause the system to fail altogether. The Army Maintenance Transformation Implementation Plan used the following chart to determine which tasks should be assigned to field and sustainment maintenance.

# Task Decision Diagram



**Figure 2 Task Decision Diagram from Army Maintenance Transformation Implementation Plan<sup>98</sup>**

The logic of the decision making diagram comes into question because of the queries used to determine task allocation and their level of subjectivity. What failure does not affect readiness? Maintenance system transformation has, by design, taken away the ability of the field level of maintenance to perform the task through training, duty description and tool resourcing so the answer is known before the question is even asked. The logic of the risk and failure rate questions is not clear and arguments could go either way for reason to assign the task to one level or another. Questions such as “does the ability to conduct task return combat power to a mission capable status sooner if task is performed at X level of maintenance” and “will the conduct of the task at X level of maintenance place undue stress on X (e.g. transportation, CL IX) system” are more relevant to a discussion of task level allocation. Perhaps the most important question, “will the ability to conduct task at X level, provide more flexibility and options to the maneuver commander” is not even hinted at. The questions set should help determine where best the ability

<sup>98</sup>Ordnance Center and School, United States Army, *Army Maintenance Transformation Implementation Plan*, Department of the Army, 2004, 20.

of the task should be placed regardless of transformation initiatives. Only this approach will provide the most relevant feedback and an honest assessment of the feasibility of transformation. It is already known where the tasks can be conducted according to transformation so instead the diagram should challenge that logic to ensure it provides the maximum effectiveness, with efficiency as an important, but secondary consideration. A discussion about effectiveness versus efficiency is an important point that will be discussed below. Any important concept must be thoroughly challenged and tested for validity and soundness. Clearly, this diagram, nor the repair forward model, meets that requirement. What follows is a discussion of the transformed maintenance organization and its role in maintenance transformation.

## **Maintenance Organization**

This section will discuss how maintenance personnel are arrayed in the readiness system and the structures used to facilitate their efforts. In respect to maintenance conducted in a brigade combat team (BCT), one of the most significant results of transformation is the advent of the forward support company (FSC). The FSC combines most, but not all, of the logistics functions once found in the DS maintenance support team from the maintenance company of the FSB and the headquarters company of the maneuver battalion. The medical platoon remains with the headquarters company of the maneuver unit in the transformed BCT.<sup>99</sup> How does the FSC stand up to the application of the General Systems Theory tenets discussed earlier in the paper? To do this assessment correctly, the influence of perspectivism must be remembered. First, the perspective of the maneuver battalion will be considered. For the maneuver battalion, the FSC is nearly an unqualified success. With the combination of organizational and certain DS maintenance conducted by one company dedicated to one battalion alone, with less interference from maintenance priorities outside of the unit, stability seems to be increased from the AoE

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<sup>99</sup> Directorate of Training, Doctrine and Combat Developments, Fort Knox, KY, *Fort Knox Supplemental Manual (FKSM) 71-8: Armor/Cavalry Reference Data, Brigade Combat Teams*, October 2005, A-15.

maintenance system. All of the control mechanisms and effectors are under the direct purview of one maneuver battalion commander and are much more responsive to the unit's needs. The level of interaction is also heightened due to, in large part, the assignment of the Standard Army Maintenance System (SAMS)-1 automation capability to the unit, to include a maintenance control section that concentrates solely on that battalion.<sup>100</sup> In the AoE maintenance system, the shop officer's attention was spread amongst the entire BCT, leaving little time to focus on just one battalion under normal circumstances. The ability of the maneuver battalion commander to return the "system" to a desired state is increased through the additional negative feedback mechanisms that the additional DS mechanics, STAMIS automation and maintenance supervisor oversight provides. With maintenance transformation being implemented as its designers would have it, the required CL IX would always be there in a timely manner to promptly swap out the broken component and get the platform returned to an FMC status.

Now, a broader perspective will be taken to finish the analysis of how the transformed maintenance system affects the readiness of the BCT. In chapter two of the Army Maintenance Transformation Implementation Plan (AMTIP), it is touted that the two level maintenance structure will allow all existing Army motor pools to have the capability to perform DS maintenance on-site.<sup>101</sup> Once again, this is nothing new as MSTs were always located in the supported unit's motor pool and conducted DS maintenance for maneuver battalions. The AoE maintenance system enabled the mechanic to perform more tasks, giving the maintenance managers more options when CL IX parts were not available, as was often the case.<sup>102</sup> This allowed for more interaction options for the BCT as a whole.

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<sup>100</sup> SAMS-1 is the STAMIS that manages direct support maintenance.

<sup>101</sup> Ordnance Center and School, United States Army, *Army Maintenance Transformation Implementation Plan*, Department of the Army, 2004, 9.

<sup>102</sup> Department of the Army, *Contingency Combat Service Support (CSS) Analysis and Documentation Report*, Center For Army Lessons Learned, 2002, 21. Further data can be drawn from Gregory Fontenot, E.J. Degen, and David Tohn, *On Point: The United States Army in Operation Iraqi Freedom*, (Kansas: Combat Studies Institute Press, 2004), 408-409.

From the BCT perspective, the ability to surge maintenance assets from one battalion to another has been greatly reduced under transformation. MSTs, which were firmly under the control of the shop officer in the maintenance company of the FSB, could move assets from MST to MST or base maintenance platoon to MST as needed. Despite the fact that the BSB “owns” the FSC, it will be much more difficult to surge assets from one FSC to another because of the blurred ownership lines created by assigning maintenance assets to a company that solely supports one battalion. Ownership of the FSCs reverted back to the BSB Army-wide in 2005 which will surely cause some difference in perspective for the FSC Commander. A unit can only have one boss, no matter how one looks at it. It will not be difficult for a maneuver battalion to justify why the battalion can’t afford to give up any assets, especially in this fast-paced environment the Army exists in today. This is not a negative comment on maneuver battalion commanders as they are supposed to do what is best for their battalion. In the AoE system, the Support Operations Officer or maintenance company commander, as an impartial third-party, could move maintenance assets as required from the BCT, not battalion, perspective. This was an excellent check and balance system that allowed for a more prudent use of CL IX. It is hard to imagine a battalion motor technician (BMT) turning down a new component versus a repaired one even if the part in question was reparable. The shop officer, with a view on BCT priorities, would assign precious major assemblies to where they are needed most. In regard to CL IX, it is doubtful that the current distribution system or any near-term one will exist to support the massive CL IX demands that a replace forward approach to maintenance will impose.

Also found in chapter two of the AMTIP is this quote; “The central theme of Army Maintenance Transformation is to provide as much sustainment support from CONUS as possible, pushing sustainment maintenance activities into a Theater only when the supply system

cannot support an operation.”<sup>103</sup> This basically states that maintenance capability forward will be replaced by supply stocks and only when these stocks are unavailable, will maintenance capability be pushed forward. It is hard to imagine a less insightful plan. To design a system with fewer options and less capability and make up for this with an item stockage that will most likely be unavailable is less than an optimum solution.<sup>104</sup> As will be discussed in the CL IX section, the trend is decreasing CL IX stocks forward, not increasing them. There are no initiatives for an increase in manufacturer capability or strategic/intra-theater airlift. There are fewer options, back up options and the result is a less effective maintenance structure than existed before.

Maintenance transformation does not just affect heavy BCTs. Transformation’s effects are also felt in light units. Then CPT James B. Swift’s article in the September-October 2005 Army Logistician very clearly and succinctly points out the shortfalls of the transformed BSB as well as the legacy FSB maintenance system. CPT Swift cites a 101<sup>st</sup> Airborne Division study that analyzed MOS 63B workloads for 10 critical vehicle fleets. The study found that 63B workload requirements were resourced during peacetime at less than 66 percent for legacy FSBs and 73 percent for transformed BSBs. Since the study only took 10 “critical” fleets into consideration, the actual percentage of personnel available to conduct required maintenance on all vehicles in the BCT will be lower.<sup>105</sup> CPT Swift’s analysis is very sound due to the objective nature of the data analyzed and displays the shortfall of both legacy FSBs and transformed BSBs effectively, but with just two potential flaws. The first potential flaw is the perceived assumption that all tasks previously considered DS are now performed at the field maintenance level. As seen in the

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<sup>103</sup> Ordnance Center and School, United States Army, *Army Maintenance Transformation Implementation Plan*, Department of the Army, 2004, 9.

<sup>104</sup> A specific comment on the inability of peacetime PLLs and ASLs to support combat operations is from a presentation titled “*Ground Maintenance Operation Iraqi Freedom*” on slide four. The document does not list an author but was obtained from CALL and is available upon request from the author. Please see also sources cited in note 103 for further examples.

<sup>105</sup> James B. Swift, “*Field Maintenance Shortfalls in Brigade Support Battalions*,” Army Logistician, September-October 2005, 5. CPT Swift has since been promoted to Major and works in the Collective Training Directorate of the Combined Arms Center at Fort Leavenworth, KS.



AMTIP definition of the transformed maintenance system, field maintenance will only conduct certain DS tasks. Though the percentages cited above will certainly be affected, the analysis is still valid because the DS tasks that will be conducted at the field maintenance level have not been entirely codified in updated maintenance allocation chart (MAC). The second flaw, one more injurious to effectiveness of the maintenance system, is his proposed solution of augmenting BSBs with full-time civilian mechanics to make up for the annual shortfall of 31,254.7 available mechanic hours in a garrison environment.<sup>106</sup> This solution very quickly and effectively resolves the maintenance shortfall but does not set the BCT up for success when it deploys to combat. The presence of civilian mechanics that will not deploy with the BCT, gets a unit used to having this capability and systems inevitably get designed around it. As aforementioned, contractors can play an important role in maintenance, but a major, permanent part of the maintenance work force is not one of them. Units must be resourced with enough mechanics to complete the required maintenance in garrison, as well as when deployed. The high manpower overhead of deployments cuts deep into maintenance personnel as they are called on to perform security requirements necessary in a hostile environment. The surplus of available man-hours noted in the article most assuredly disappears under these austere conditions. Nonetheless, CPT Swift's article is a sound and logical representation of the shortfalls of the transformed BSB.

The discussion above clearly shows the incongruence of the transformed maintenance structure and other transformation initiatives. Here is an excerpt from the Congressional Research Service for Congress report dated 20 May 2005:

One concern is that that while most or all of the active Army's combat brigades will be transformed to the UA structure by 2007, the rest of the Army will still be organized along traditional lines. Exacerbating this concern is that a substantial number of [S]oldiers and selected equipment from these supported units were incorporated into the UAs, leaving the supporting units with only a residual support capability. Although UAs-theoretically-should be more self-supporting,

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<sup>106</sup> Ibid, 7. Based on the number of required man-hours (63B in a BSB-FSB) for just 10 vehicle fleets and the available man-hours for 63B mechanics in a BSB-FSB.

some question the ability of these “down-sized” support units to provide UAs with required support.<sup>107</sup>

The report goes on to state concerns that support units will compete with the UAs (brigade combat teams) for personnel and equipment and because of Army prioritization of UAs over support units, the shortages in manning and equipment in support units of action (SUA) will be even more pronounced.<sup>108</sup> The report also shows the result of unit restructuring with many unit types being reduced. Logistics units far exceed any other unit type reduction with a decrease of 65 units.<sup>109</sup> The bottom line is that transformation does not adequately resource maintenance capability and that support units will be the losers for much needed funding allocations. What further exacerbates the problem is that the main support battalion (MSB) and division support command (DISCOM) have been removed from the BCT maintenance capabilities option menu. Though this fact leads to another topic entirely, as it lies outside of the sole realm of maintenance transformation, it is important to point out that an important source of habitual, back-up maintenance and CL IX was removed from an already fragile readiness system. The discussion presented in the next chapter on sustainment brigades give reasons why sustainment brigades will have issues providing this back-up support. Furthermore, the replacement of the division materiel management center (DMMC) with the much less capable distribution management center (DMC) takes away another valuable tool the FSB readiness managers could rely on to make up for foreseen as well as unexpected shortfalls encountered in the pursuit of readiness. In fact, units that are transforming are reluctant to give up these valuable assets resulting in the DMMC and DISCOM structures remaining, if only by another name and less capability.<sup>110</sup>

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<sup>107</sup> Andrew Feickert, *U.S. Army's Modular Redesign: Issues for Congress*, (Washington D.C.: Congressional Research Service, Foreign Affairs, Defense, and Trade Division, 2005), 7, CRS RL32476.

<sup>108</sup> Ibid., 7.

<sup>109</sup> Ibid., 18.

<sup>110</sup> This comment is supported by the current G-4 planner in the 4<sup>th</sup> ID and communicated via email to the author. A copy of the email is available from the author.

## Impact of transformation on CL IX

The final section of the analysis will deal with the impact of transformation on CL IX; stockage as well as distribution of these stocks. This is where historical data becomes most relevant. CL IX always leads to a hard and indisputable fact: you either have it or you don't. Transformation in the CL IX arena does not seem to make the situation better but possibly worse. The AMTIP states in a discussion about sustainment repair that "[I]f the growth in sustainment repair trend continues there will be an increase in the number of repairables [sic]".<sup>111</sup> What this means to the maintainer is that because more CL IX components are being replaced forward and not repaired forward, the sustainment level of maintenance will be unable to handle the additional workload without significant additional resources. The AMTIP banks on the ability of the two-level maintenance system to quickly acquire parts at or near the point of failure to regenerate future combat system (FCS) combat power. Emerging FCS doctrine requires units to operate for three days in a high OPTEMPO environment and seven days in low to medium environment without the need for a sustainment pause.<sup>112</sup> The Army is planning that the FCS will be able to perform this impressive maintenance feat and the operating environment will allow this sizable low to medium OPTEMPO period. If these forecasts prove true, the changes in CL IX will be less damaging. Neither the contemporary operating environment (COE) nor near-future technological advances show any indication these will occur to realize the transformational system now when it is needed to sustain operations. Since no combat platform exists today with that capability, shaping CL IX policy based on a hoped for future capability that greatly reduces CL IX requirements is questionable. Today's CL IX policies have to be designed for today's vehicles and today's vehicles need a steady and on-hand supply of CL IX. No amount of velocity

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<sup>111</sup> Ordnance Center and School, United States Army, *Army Maintenance Transformation Implementation Plan*, Department of the Army, 2004, 21.

<sup>112</sup> *Ibid.*, 28.

management (VM) or in-transit visibility (ITV) can replace having the required CL IX on hand to repair a vehicle quickly.

Certain senior leaders in the United States Army try to incorporate successful business practices into Army logistics. RFID is one example of a technology used by the commercial sector that pays great dividends for Army readiness. Because something works in the civilian sector does not mean it will work in the military, especially in a deployment situation. When deployed, a logistic unit may move several times a month. It is not always able to tap into a communications infrastructure to gain connectivity and pass information quickly. The unit it supports is constantly on the go with requirements changing rapidly. Civilian businesses also do not tolerate a lack of manufacturer supply. The GAO report cited in LTC Maccagnan's article notes the inability of the industrial base, as well as the wholesale supply system to have the required number of high demand CL IX parts. The failure of commercial logistics systems to adequately deliver supplies and repair parts to the theater is also noted.<sup>113</sup> The list of differences goes on. None of this exists to the same degree in the civilian world and as such, commercial practices are not readily transferable to the military. The purpose of a civilian business is to make money which is completely different than the purpose of the Army CL IX supply system which is effective readiness. The different purposes alone show cause to question the adoption of proven business practices without proper analysis. The Army has to take a hard look at what is available and determine what practices will meet the needs of the Army, adopt them, resource them and train personnel in their application.

Though CL IX availability is a major problem in maintenance operations even before transformation, it is not the only one. The Center for Army Lessons Learned (CALL) states in reference to maintenance operations during recent conflicts that "the supporting tech supply

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<sup>113</sup> GAO-04-305R: *Defense Logistics: Preliminary Observations on the Effectiveness of Logistics Activities During Operation Iraqi Freedom*, (Washington, DC: U.S. General Accounting Office, 2003), 3; paraphrased in Victor Maccagnan, "Logistics Transformation-Restarting a Stalled Process" (monograph, United States Army War College, 2004), 12.

operation does not stock the necessary parts” for maintenance of low-density items.<sup>114</sup> CALL

sums up many problems in this excerpt found earlier in the aforementioned report:

Units need to establish better CL IX package configurations for MSTs to enhance capability to fix forward. Additional transportation assets must be allocated to these teams to carry and hold major assemblies. Split based operations create a need for duplicate equipment sets, particularly in information systems such as SARSS, SAMS, etc., that are essential to the distribution process.<sup>115</sup>

There are also accounts of inadequate transportation assets during OIF and Operation Desert Storm (ODS). LTC Maccagnan cites Anthony Cordesman’s observation that the Army simply did not have enough trucks to sustain the long distance supply chain during OIF.<sup>116</sup> LTC Maccagnan also cites a United States General Accounting Office observation of a backlog of hundreds of pallets and containers at various distribution points, consisting of an uncategorized mix of serviceable and unserviceable parts, deteriorating due to a lack of protection from the harsh desert conditions. The lack of sufficient transportation resources was definitely a major, but not sole, cause of this deficiency.<sup>117</sup> Transportation facilitates the negative feedback scheme of the CL IX system. A broken part represents the undesired state in a system. Transportation, like mechanics discussed in the previous section, is an effector that allows the system to return the system (vehicle) to its desired state. If the part is not on hand, not able to be transported promptly and can’t be locally repaired by trained and resourced mechanics, commanders and readiness managers have little recourse but to just wait and hope. In *On Point: The United States Army in Operation Iraqi Freedom*, a similar observation is made; “logistics in OIF were less than

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<sup>114</sup> Department of the Army, *Contingency Combat Service Support (CSS) Analysis and Documentation Report*, Center For Army Lessons Learned, 2002, 21

<sup>115</sup> Department of the Army, *Contingency Combat Service Support (CSS) Analysis and Documentation Report*, Center For Army Lessons Learned, 2002, 17.

<sup>116</sup> Anthony H. Cordesman, *The Iraq War: Strategy, Tactics, and Military Lessons*, (Connecticut, Praeger Publishers, 2003), 206; paraphrased in Victor Maccagnan, “*Logistics Transformation-Restarting a Stalled Process*” (monograph, United States Army War College, 2004), 11.

<sup>117</sup> GAO-04-305R: *Defense Logistics: Preliminary Observations on the Effectiveness of Logistics Activities During Operation Iraqi Freedom*, (Washington, DC: U.S. General Accounting Office, 2003), 3; quoted in Victor Maccagnan, “*Logistics Transformation-Restarting a Stalled Process*” (monograph, United States Army War College, 2004), 12.

an unqualified success.”<sup>118</sup> It continues with validating examples one of which is: “[R]epair parts for vehicles and equipment simply didn’t make it forward to attacking units. Brigades that attacked north from Kuwait and defeated the Iraqi forces in Baghdad did so without receiving any repair parts whatsoever.”<sup>119</sup> *On Point* goes on with many accounts of logistical failures resulting from transportation platform shortfalls. The point of this discussion on CL IX is simple. The Army needs to resource its units with more CL IX and more transportation to carry it. This is the way it has to be until the distant vision of FCS or whatever future vehicle is realized.

OIF was not the only conflict to have the issues relating to CL IX and transportation. ODS and Operation Enduring Freedom (OEF) shared many of the same shortfalls as pointed out in many for official use only (FOUO) reports such as the Tait Report and the Combined Arms Assessment Teams (CAAT) review of OEF. Though different reports often have different interpretations or observations of events that occurred while the United States Army was in conflict, a common theme resounds throughout. CL IX and sufficient transportation capability are inextricably linked and both must be present for any maintenance system to be successful. The degree that adequate CL IX stocks and transportation platforms are on-hand is directly proportional to the success of maintenance when knowledgeable, properly resourced mechanics are available.

The next section provides examples of how the Army maintenance system can be improved with technology and capabilities that are available today. These are options that do not depend on future technological advances or inadequately resourced concepts. They are applicable now and will bolster the maintenance system the Army depends on to sustain itself in a challenging operating environment.

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<sup>118</sup> Gregory Fontenot, E.J. Degen, and David Tohn, *On Point: The United States Army in Operation Iraqi Freedom*, (Kansas: Combat Studies Institute Press, 2004), 408.

<sup>119</sup> *Ibid.*, 409.

## IV. EASY FIXES

The title of this chapter does not mean to imply that the problems that the Army's maintenance system has are in any way simple and easily remedied, because they aren't. The title means to convey that many of the maintenance system issues faced today could be mitigated with solutions that are not "transformational" or spurred by a "revolution in military logistics." The Army already has the capability to make the system better with the tools it possesses. Advantages presented by emerging technology should always be exploited but effectiveness can be significantly increased by doing the routine things routinely. What follows is a discussion of maintenance sub-systems, or related systems, which could be improved through stricter discipline in application, closer supervision, better leadership and management, and perhaps most important, hard work. These are actions that can be taken now, and should have been done all along, without waiting for transformational enablers. This section will not address potential or foreseen deficiencies already mentioned in previous chapters related to maintenance transformation efforts. This discussion is also not meant to be exhaustive but to highlight key areas for immediate improvement in maintenance operations.

A long-standing problem for CSS units has been the inability to communicate over long distances. This scale of this problem has increased because of the nature of the conflicts the United States Army is involved with today. Operational requirements vastly out-distance today's CSS unit's capability to communicate. Communicating over greater distances will allow the direction and coordination of resources required to conduct the type of operations the Army is in currently and presumably will be in the future.<sup>120</sup> An observation made in *The Army's Initial Impressions of Operations Enduring Freedom and Noble Eagle* is that the paucity of reliable long distance communications in Army logistics units resulted in the inability to communicate in a

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<sup>120</sup> Conrad C. Crane, *Final Report: The U.S. Army's Initial Impressions of Operations Enduring Freedom and Noble Eagle*, (Carlisle Barracks, Pennsylvania, U.S. Army War College, August 2003), quoted in Victor Maccagnan, "Logistics Transformation-Restarting a Stalled Process" (monograph, United States Army War College, 2004), 8.

timely or effective manner so they could execute the most basic of logistics tasks.<sup>121</sup> One potential solution is the Tactical Automated Combat Service Support Systems Shelter (TACS-4). TACS-4 is a self-contained, climate controlled, communications shelter that is highly mobile and quickly put into operation in a tactical environment. Its vast potential was glimpsed in a Combat Maneuver Training Center (CMTC) rotation in 2003. Once the TACS-4 arrives at the selected site, it is put into operation in mere minutes and provides vital communications capability.<sup>122</sup> It was cost prohibitive and its current status is unknown. Another available tool is the very small aperture terminal (VSAT) satellite system. 900 VSATs have been fielded, along with associated CSS automated information system interface, battle command sustainment support system and more than 4,500 movement tracking systems.<sup>123</sup> Though this is a notable effort in improving the communication ability of logistics units, the article admits that “much work remains.”<sup>124</sup> The point is that the capability is out there, it just needs to be resourced and used.

A closely related issue is that of bandwidth. The complexities of bandwidth cannot be dealt with in this paper but the lack of bandwidth is limiting factor for logistics today and crippling factor for logistics in the future if bandwidth issues still exist. As is the case with many resources, more bandwidth is needed. The Department of Defense, in conjunction with civilian firms, is working to bring about advances in information technology (IT) that will support the massive requirements of the transformed Army. One of these advances is Internet Protocol Version six (IPv6). IPv6 will dramatically increase the amount of bandwidth and internet protocol (IP) addresses available.<sup>125</sup> Before it can be implemented, there are many issues such as compatibility with current systems, security and quality of service. The troubling fact is that the

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<sup>121</sup> Ibid., 8.

<sup>122</sup> Frank V. Gilbertson, *Readiness Excellence at the Combat Maneuver Training Center*, (KS, Center for Army Lessons Learned, Combat Training Center Bulletin, 3<sup>rd</sup> Quarter, 2004), 5.

<sup>123</sup> Claude V. Christianson, “Enhancing Logistics Readiness,” *Army Magazine*, October 2005, 174.

<sup>124</sup> Ibid., 174.

<sup>125</sup> David Green, Bob Grillo, *The State of IPv6: A Department of Defense Prospective*, February 2005, (Washington, D.C., SRI International, DoD IPv6 Standards Working Group, February 2005), 37.



United States is not the leader of this emerging technology. Asian countries, China in particular, launched its version of IPv6 well over a year ago. China's emphasis on this technology resulted from U.S. dominance in the IT field, forcing them to develop the technology to compete. The China Education and Research Network-2 (CERNET2) is the largest next-generation Internet network in the world and connects 25 universities in 20 different cities. The speed in the network reaches 2.5 to 10 gigabits per second.<sup>126</sup> While the advantages of this network to China's education system are clear, it must be assumed that China's military, an emerging threat to U.S. military dominance, is exploiting it as well.

Whether increased bandwidth is achieved through advances in technology, resourcing units or IT management, it is clear that more bandwidth and communication capability must be supplied to the Army's forces. It is also clear that the United States is not the leader it once was in IT.<sup>127</sup> Increased connectivity will allow for the increased transfer of data, supporting current STAMIS systems managers with higher levels of situational understanding. This, in turn, will allow maintenance leaders to make better decisions, and tied to a more robust transportation and distribution network, will get them the CL IX resources they require.<sup>128</sup>

What better connectivity provides is better situational understanding. Better situational understanding gives us a clear picture of requirements. In the maintenance system, one result of situational understanding is knowing what CL IX is needed. Ordering the right part the first time and knowing its status in the pipeline will decrease the burden on the Army's under-equipped transportation system. "The underpinning of logistics transformation and Focused Logistics is based on ensuring the right commodity is delivered to the right place, in the right quantity and

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<sup>126</sup> Liu Baijia, "China Launches New Generation Internet," China Daily 27 December 2004 [newspaper on-line]; available from [http://www.chinadaily.com.cn/english/doc/2004-12/27/content\\_403512.htm](http://www.chinadaily.com.cn/english/doc/2004-12/27/content_403512.htm); Internet; accessed 13 February 2006.

<sup>127</sup> Ibid.

<sup>128</sup> For observations on lack of logistics connectivity see Eric Schmitt, "Army Study of Iraq War Details a 'Morass' of Supply Shortages", *New York Times*, February 3, 2004, sec. A, p. 1, [database on-line], available from ProQuest, cited in Victor Maccagnan, "Logistics Transformation-Restarting a Stalled Process" (monograph, United States Army War College, 2004), 11-12.

configuration, and at the right time with the minimal logistics footprint forward in the area of operations.”<sup>129</sup> Sense and Respond Logistics also relies on a robust and flexible transportation network, one that does not exist today or in the foreseeable future. A CALL study provides examples of where “logistics distribution and management systems,...failed to adequately support the requirements of OIF forces.”<sup>130</sup> The DoD must invest in more transportation assets to make the required transportation network a reality. This does not just involve intra-theater ground transportation, but also strategic airlift to provide the necessary support to operational theaters. Today’s transportation system is already ill-equipped to support forces deployed.

The added requirement placed on the distribution system by concepts such as VM, Sense and Respond Logistics and JIT will cause a complete breakdown of support. These concepts, as well as the replace forward approach discussed earlier in the paper, require many more trips with the potential for less than truckload (LTL) shipments, which is of course is a less effective use of available assets. Intra-theater airlift, both rotary and fixed wing would greatly augment the Army’s ability to support forces in the field and unblock the clogged TDCs in theater. Transportation and CL IX serve as key components in the negative feedback scheme of the Army maintenance system and increasing this capability would significantly decrease order ship time (OST-the amount of time between a commodity being ordered and when it is shipped) and mean time to repair. The measure of the maintenance system’s success is largely measured in the speed of the system’s execution. A robust transportation system is useless without CL IX available to move. The United States’ industrial base must also be engaged and increased to meet the

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<sup>129</sup> Maccagnan, 18.

<sup>130</sup> U.S. Army Operation Iraqi Freedom Study Group, “U.S. Army Operations Iraqi Freedom Observations Quick Look,” (KS, Center for Army Lessons Learned, August 2003), slide 16 of 88, available from <https://call2.army.mil/oif/brief.asp>, Internet, cited in Victor Maccagnan, “*Logistics Transformation-Restarting a Stalled Process*” (monograph, United States Army War College, 2004), 11.

fluctuating needs of an Army in conflict. As it currently stands, the industrial base is not capable of meeting the needs of the Department of Defense.<sup>131</sup>

Modularity is seen as a vital component to transformation in general. It could be argued that today's logistics units lack the modularity required to support the force in conflict today. One measure that has enjoyed differing degrees of success is the derivative unit identification code (UIC) process. Often this process is seen as too cumbersome and left unused. This is from the lack of training and preparation of units as well as DMMCs. When properly utilized, a derivative UIC can be used to stand up any unit required to complete a mission. In coordination with the Department of Defense address activity code (DODAAC), derivative UICs allow for STAMISs to be established for use, delivery addresses for supply coordination and billing. If understood, they can be a valuable tool for tailoring any logistics unit for the mission at hand. With the dissolution of the MSB, many assets are now removed from the pool of availability. Logistics units are seen as the "bill-payers" in the transformation process and are forecasted to lose many personnel in what was once known as the division rear area. Sustainment brigades, which will replace DISCOMs and MSBs, will not be standing logistical units. They will be manned when needed with the resources required to support the assembled maneuver force.<sup>132</sup> This is in direct conflict with the concept of unit manning. Unit manning is supposed to allow a unit to train and deploy together in three year increments. A sustainment brigade will not only be unable to train with the unit it will support, but with itself. Support will obviously not be habitual which is clearly less desirable than habitual support. With 13 planned active component sustainment brigades, it seems unlikely the C2 architecture will support the employment of

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<sup>131</sup> As a result from a CALL research request, an email from Mr. Scott Blaney, a Veridian contractor attending a "strategic thinking" course, was received by the author. It details comments from General Schoomaker that discuss how the American industrial base is not geared to support the Army's requirements and that the military is under funded. It is dated 12 January 2004 and is available from CALL or from the author.

<sup>132</sup> Department of the Army, The Sustainment Brigade, FM 4-93.2 (Coordinating Draft), Washington, D.C., No date, 2-10.

transformed BCTs in multiple theaters simultaneously, especially if some of the 13 active component sustainment brigades are designated as theater opening (TO) or theater distribution (TD) which is still unclear at this time.<sup>133</sup>

In addition to increased connectivity and transportation, logisticians must be able to monitor the status of CL IX in the pipeline. This is capable largely through RFID and ITV. The technology to allow this is already there. The issue is the lack of interrogators in theater or improper use of the RFID system. Often, data cards are improperly “burned” with incomplete or inaccurate data. Visibility of CL IX upon arrival in Kuwait during OIF was nearly zero due to inaccurate or missing RF tags, inadequate access to TAV systems within theater and insufficient interrogators projected forward as supply lines extended into Iraq.<sup>134</sup> These issues, compounded with severe problems at the TDC caused “...a backlog of hundreds of pallets and containers of materiel at various distribution points...” and resulted in “...a wide array of materiel, spread over many acres, that included a mix of broken and useable parts that had not been sorted into appropriate supply class, unidentified items in containers that had not been opened and inventoried, and items that appeared to be deteriorating due to harsh desert conditions.”<sup>135</sup> CL IX for several different units is often commingled when containerized for shipment to theater. This makes sense as it makes the best use of precious haul capability. This commingled shipment is tagged and shipped to theater. Upon arrival, the shipment must be broken down for delivery to various supply points or units in theater. The problems start when these new configurations are not properly tagged so they can be tracked in theater. Cards are labeled “general cargo” instead

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<sup>133</sup> This information is contained in an email correspondence from Barry Richards, Force Development from CASCOM at FT Lee, VA, phone number 687-2064 (DSN), barry.richards@us.army.mil to MAJ Frank V. Gilbertson on 8 January 2006 with subsequent replies on 31 January 2006. Correspondence is available upon request from the author.

<sup>134</sup> GAO-04-305R: *Defense Logistics: Preliminary Observations on the Effectiveness of Logistics Activities During Operation Iraqi Freedom*, (Washington, DC: U.S. General Accounting Office, 2003), 3; quoted in Victor Maccagnan, “*Logistics Transformation-Restarting a Stalled Process*” (monograph, United States Army War College, 2004), 12.

<sup>135</sup> Ibid, 12.

of a detailed manifest that identifies each part and document number in the shipment. This can and must be remedied. No amount of transformation enablers can fix poor workmanship.

Widespread abuse of the priority designator (PD) wreaks havoc on the CL IX system.<sup>136</sup> If everything is ordered high priority, then nothing is high priority. Failure to follow established maintenance SOPs and hold maintenance supervisors accountable for work also creates tension in the maintenance system. The causes of inefficacy are many but the maintenance system has the capability to resolve many of the issues already. An example of this capability is the use of Six Sigma quality management tools to increase quality of work. Failure of depot level repairables (DLR) failing right out of the can not only increase CL IX costs but also add a significant additional burden to the transportation system. With the AMC adoption of Six Sigma practices, the mean time between overhauls of the T700 engine (UH-60) increased to over 900 hours from 309 accompanied by a reduction of overhaul cycle time from 300 plus days to 80. Throughput of high mobility multi-purpose wheeled vehicles (HMMWV) through the recapitalization initiative at Red River and Letterkenny Army Depots was increased from six vehicles a day to 26 with a 50% reduction in repair cycle time and 33% reduction in costs. The upgrade of HMMWVs to ground mobility vehicles (GMV) for SOCOM netted a savings of \$990,000 due to Six Sigma process management tools.<sup>137</sup> Whatever form quality management comes in, it must be thorough in its design and ruthless in its application.

This is where logistics leaders must weigh in. Logistics leaders must demand quality work from their organizations and be knowledgeable enough to judge the effectiveness of their systems. They also need to vigorously request the required assets to do this, such as portable data carrying devices (PDCD), RF interrogators, TAV access and whatever else the mission requires.

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<sup>136</sup> Department of the Army, Tank-Automotive and Armaments Command, Memorandum for Record, *Meeting Minutes "Kuwait Support"*, POC listed as CW4 Cushman, 14 February 2003. Received as a result of a research request from CALL. Available upon request from author.

<sup>137</sup> Benjamin S. Griffin, "Department of Defense Maintenance Symposium", briefing slides, FT Belvoir, VA: Army Materiel Command, 27 October 2005, slide 12.

LTC Maccagnan identifies leader development as the most important logistical transformational change that must occur. Whatever road transformation takes, logistics leaders at all levels must be thoroughly knowledgeable how the many different systems work together. Innovation and creativity will always be hallmarks of successful logistical leaders because there will always be shortfalls and deficiencies to be overcome.<sup>138</sup> The key is to provide logistical leaders the flexibility, training and assets to overcome them.

The final chapter of the paper will look at how maintenance transformation measures up against the system aspects discussed and what needs to be done to posture the maintenance system for success. The easy fixes in this chapter would definitely make the current and transformed system better but do not provide all the solutions required to sustain the Army in the COE or the foreseen future. Improvements in design need to be made to both systems to allow the Army to leave its dependency on brute force logistics behind. When designing a system, system attributes must be prioritized. An important discussion for the maintenance system in regard to attributes is the prioritization of effectiveness and efficiency. The conclusion offers some remarks about this topic about which should take priority.

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<sup>138</sup> Maccagnan, 29.

## V. CONCLUSION

When boiled down to its essence, maintenance transformation is a contest between effectiveness and efficiency. Both have their benefits and costs but the increase in one usually results in the decrease of the other. One consideration must have precedence over the other when a decision point is reached in the process of designing the transformed maintenance system. This does not mean the wholesale disregard of one over the other, but a balanced approach that will optimize the advantages of both while minimizing the costs of either. How does one determine which consideration, effectiveness or efficiency, should take priority? Here is one approach from Don Snider and Gayle Watkins in *The Future of the Army Profession*.

Medical professionals perfect medical techniques to apply to patients, lawyers apply legal expertise in trying cases, and the military develops new technologies, capabilities, and strategies to provide for “the common defense,” most often in places and under circumstances that cannot be foreseen. Such professional expertise is ultimately validated by the client (or professions would not exist!), and forms the basis for the trust between the profession and the society served. Given such trust, professions are granted limited autonomy to establish and enforce their own professional ethics, the maintenance of which further enhances such trust. Furthermore, success in professional practice stems from effective and ethical application of the expertise – the patient is cured, the case is won, conflict is deterred, or if fought, settled on terms favorable to the United States. Thus measures of efficiency, while important, rank behind effectiveness as measures of success for professions.<sup>139</sup>

LTC Maccagnan adds to the discussion with this CALL reference in his monograph.

The [OIF Study Group] report is damning in both its findings and its stated context. The base finding was that, “Logistics distribution and management systems, weakened by a late deployment of support units, failed to adequately support the requirements of OIF forces.” It continues that the, “Decade-long effort to digitize logistics, adapt ‘business practices’ and promote efficiency over effectiveness [is] insufficient for [the] contemporary operating environment.”<sup>140</sup>

System goal or intent determines the ranking of effectiveness and efficiency. The purpose of commercial business is to make money so it is feasible to establish efficiency as the

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<sup>139</sup> Don M. Snider and Gayle L. Watkins, *The Future of the Army Profession* (New York: McGraw-Hill Primis Custom Publishing, 2002), 7.

<sup>140</sup> U.S. Army Operation Iraqi Freedom Study Group, “U.S. Army Operations Iraqi Freedom Observations Quick Look,” (KS, Center for Army Lessons Learned, August 2003), slide 16 of 88, available from <https://call2.army.mil/oif/brief.asp>, Internet, cited in Victor Maccagnan, “*Logistics Transformation-Restarting a Stalled Process*” (monograph, United States Army War College, 2004), 11.

guiding principle when designing business plans and practices. The mission of the Army is to “Fight and win our Nation’s wars by providing prompt, sustained land dominance across the full range of military operations and spectrum of conflict in support of combatant commanders.”<sup>141</sup> Very little analysis is needed to ascertain the differences in the Army’s goal, and maintenance’s role in achieving it, and that of the commercial world. To accomplish the very difficult mission laid out before it, the Army must be an effective organization. Efficiency, albeit an important consideration, is not necessary in itself and must be considered secondary in importance.

With the above discussion in mind, the question of maintenance transformation arises and if it is on the right path to support the Army in its mission of fighting and winning our Nation’s wars. The inescapable conclusion is a resounding “no.” Maintenance transformation is under resourced and does not provide for a cogent system. It lacks the CL IX, transportation and possibly the expertise to be an effective system. The reliance on contractors and the belief that they are the panacea to high maintenance costs will only lead to more system degradation. The maintenance system must have effective feedback schemes with sufficient effector capabilities to bring the system back to a desired state. The AoE maintenance system attempted to do this through a repair forward approach, forward-positioned CL IX stocks and echeloned combat service support forward with emphasis on direct support relationships to supported units. The transformed maintenance system, which will have an even greater deficiency of CL IX stocks unless significant additional resources are quickly built into the design, attempts to rectify maintenance shortfalls with concepts such as Focused Logistics, MCM and VM. Unfortunately, these transformation enablers either do not exist in practice or have not been sufficiently resourced. Furthermore, maintenance transformation takes away many of the tools once available in the AoE maintenance system that provided the flexibility to survive in a resource constrained environment, allowing it to stave off system failure. A review of history clearly indicates

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<sup>141</sup> United States Army, “Organization: Mission Statement,” United States Army Webpage; available from <http://www.army.mil/organization/>; Internet; accessed 16 February 2006.



shortfalls in the AoE maintenance system and related systems that are not addressed in transformation such as insufficient transportation assets and new issues presented by transformation such as MCM.

As can be determined from the discussion presented in this paper, logistics was a bill payer for many transformation efforts. The goal of a reduced logistics footprint is a worthy one, but capability shortfalls cannot be ignored without consequences. The maintenance system must be approached from a capability basis, not a solely cost-effective one. System efficiency is an important consideration and efforts to improve efficiency should be made as long as system effectiveness remains at acceptable levels. Brute force logistics should be the exception, not the rule. High priority requests for parts should be a rare, extreme measure but is often the normal method of obtaining critical CL IX. The resources needed to effect repairs should be readily available to sufficiently trained maintainers close to the maneuver units, not miles away with a reliance on civilian contractors that may not be available when needed. The maintenance system should be postured so that redundant means are available to correct maintenance faults forward. If the component is not available in the CL IX system, then the maintainer forward should have the expertise, tools and resources to fix the component forward and return the vehicle to the fight. This will not be the case in the transformed maintenance system as it is designed now.

The proposed maintenance transformation does not provide the interaction, feedback or system stability required in the COE. With fewer, less capable mechanics forward, less interaction is possible and the reliance on CL IX increases because components must be replaced instead of repaired. As a result, more transportation assets will be needed to supply the increased CL IX demands. As mentioned in the paper, the Army does not have the transportation assets now to support the force. Feedback will also be reduced because of the inability to effect changes to the system. Referring back to figure 1, it is clear that MCMs, serving as the receptor in the feedback scheme, will be unable to conduct required maintenance because of the lack of CL IX, repair equipment and training. The AoE maintenance system, though possibly more complex,

benefits from that complexity. The higher complexity allows for the AoE maintenance system to be more flexible which in turn allows for the system to have a higher critical limit and therefore more stability. In the transformed maintenance system, if the component is not available, then there is little recourse but to wait for the new component to arrive. The next level of support outside of the brigade is the sustainment brigade, which by design, has not trained together, much less than with the BCT that it is supporting. It is likely that CL IX will be problematic because of the aversion to costly CL IX stocks and the inability of the industrial base to quickly respond to materiel shortfalls.

If the United States Army was involved in sustained high-intensity combat (HIC) operations, the maintenance system, and in turn the logistics system, would fail for the reasons mentioned in the paper. There is insufficient redundancy in the system. A lacking industrial base is unable to increase its output fast enough to promptly provide the materiel needed for sustained HIC operations. Just as the Army has been given a mission that it cannot fail in, the Army in turn has an obligation to provide its Soldiers the best equipment, resources and training it can for the missions they are assigned to. Nothing less should be allowed for the most valuable asset this Nation has given to fight and win its wars-the Soldier. The biggest risk if transformation fails is not financial loss, but the lives and well-being of Soldiers.

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